MACHINERY.

August, 1904.

THE ZOELLY STEAM TURBINE.

A steam turbine now attaining a prominent place abroad is the Zoelly turbine which has been developed and is now manufactured by Escher, Wyss & Co., Zurich, Switzerland, the famous manufacturers of hydraulic turbines, water-wheel governors, etc. A number of large German firms, of which the Krupps are one, are reported also to have formed a syndicate for the manufacture and sale of this turbine on a large scale.

The Zoelly turbine is of the impulse type and its general arrangement is evident from the half-tone illustration, Fig. 1, and the line drawing, Fig. 2, almost without explanation. The turbine is divided into two parts, encased separately, and placed far enough apart to permit a bearing to be located between them for supporting the shaft at the center. In Fig. 1 the top of the casing of the low-pressure compartment is lifted, exposing the wheel blades to view, and in Fig. 2 the same compartment is shown in section. The construction of the high-pressure section is entirely similar to the low-pressure, except that the steam passages have less area. This is because the steam expands as it flows through the turbine; and the steam passages, which are comparatively small at the high-pressure end, must gradually increase in area to provide for the increased specific volume of the steam.

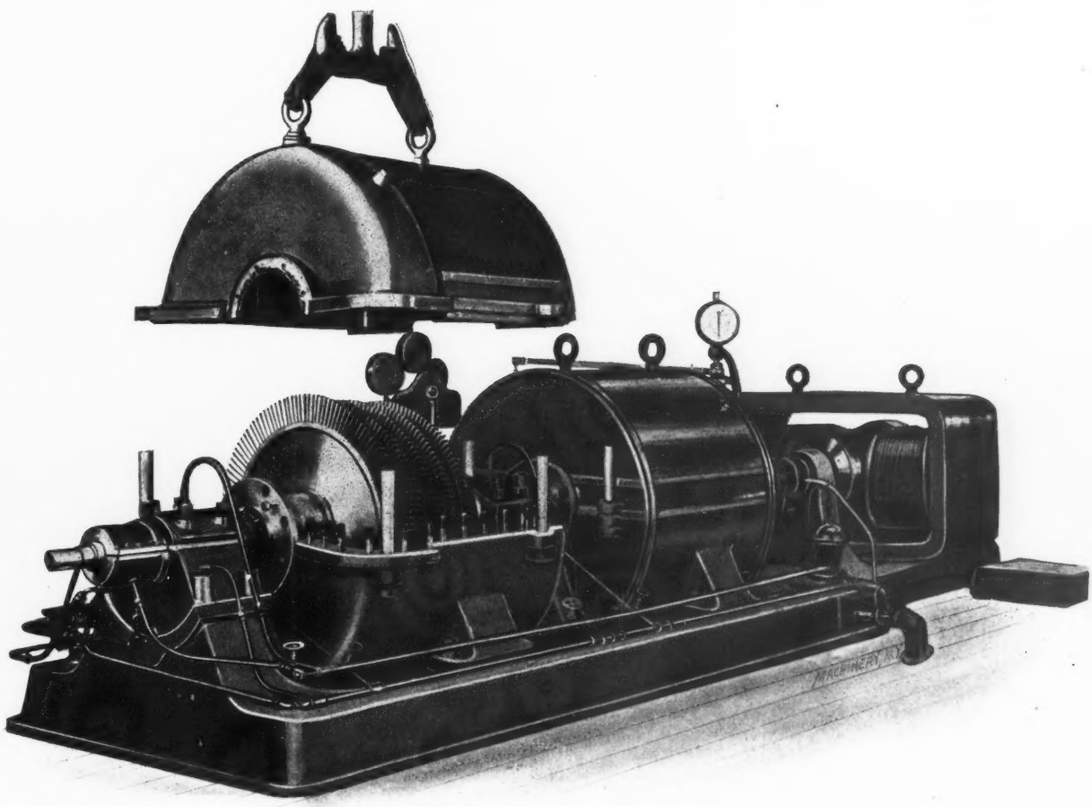

Fig. 1. Zoelly Steam Turbine, built by Escher, Wyss & Co., Zurich, Switzerland.

In this turbine there are ten rotating wheels constructed in the form of circular disks, attached to the same shaft and carrying curved blades on their peripheries. For each wheel there is a set of guide vanes for directing the steam against the rotating blades. These guide vanes give the steam the proper direction of flow and allow it to expand a certain amount as it passes through the guide passages, their function being the same as that of the steam nozzle in the De Laval turbine. Each wheel rotates in a chamber by itself, the walls of which are formed by the disks to which the guide vanes are attached. The steam enters at *A*, Fig. 2, and passes through a throttle valve operated by the governor, to the high-pressure compartment. Here it flows through the first set of guide passages, and impinges against the blades of the first wheel. The guide passages permit the steam to expand to the somewhat lower pressure of the first chamber and thus partially convert its potential energy to kinetic energy, which is mainly given up to the rotating wheel, since the steam leaves the wheel at a low velocity. The steam now passes through the passages of the second guide disk, expands to a lower pressure and is directed against the blades of the second rotating wheel in the second compartment, where it again gives up its kinetic energy. When the last step is reached in the low-pressure compartment the steam finally exhausts, either into a condenser or into the air.

At the beginning of the high-pressure section, the guide vanes occupy only a part of the periphery of the turbine, but toward the end of the low-pressure part they extend around the whole circumference. It will be noted in Fig. 3 that the passages through the guide vanes have parallel sides; that is, the walls do not diverge as in the nozzles of the De Laval turbine. This construction is based on the well-known fact that steam will expand and convert its available heat energy into kinetic energy, or the energy of motion, by flowing through a nozzle having straight, parallel sides, provided the final pressure is not less than six-tenths of the initial pressure; whereas, if the final pressure is less than this, the walls of the nozzle must diverge in order to fully expand the steam.

In the Zoelly turbine the expansion occurs in successive steps and the pressure does not drop sufficiently at any one step to make guide passages with diverging sides necessary.

It will be noted further, from Figs. 2 and 3 that the passages through the wheel blades have their inner sides inclined, producing channels of gradually increasing area. This is not, however, to allow for expansion. In this turbine, as in others of the impulse type, the pressure of the steam does not change in passing through the rotating wheel. The pressure is uniform throughout the chamber in which the wheel turns, making a drop in pressure in passing through the wheel impossible, and hence the only effect of the sloping sides of the wheel passages is to cause the steam to flow smoothly, without eddy currents, into the next guide passages, which are of larger area than the ones preceding. The conditions under which the steam flows through the wheel are entirely different from those which influence the flow through the guide vanes, for the latter have a higher pressure on one side than on the other.

The fact that each wheel is running in a medium of uniform pressure eliminates entirely any end thrust of the shaft and reduces the leakage through the clearance spaces between the wheel and guides to little or nothing.

Enlarged sections of the wheels and guides are shown in Fig. 3. The principal difference between the Zoelly turbine and others of similar type, such as the Rateau, which has already been described in these columns, lies in the construction of the details of the turbine wheels. These are designed to permit a high rotative speed without straining the material, which makes it possible to reduce the number of steps used in the turbine to a minimum. The wheels are forged of one piece, including the hub, from Siemens-Martin steel and a T-slot is machined out of the circumference of the disk to hold the blades and their distance pieces as shown in Fig. 3. One side of the slot is closed by a wrought iron ring, *r*, which is riveted to the disk. The blades are radial, and made of nickel steel, highly polished, which resists erosive action very effectually. The cross section of the blades decreases as the radius increases, thus reducing the stresses due to centrifugal force to a minimum. The blades and distance pieces are milled by special machinery.

The disks which hold the guide vanes and separate the turbine into compartments, are bored out to receive the hubs of the turbine wheels, as shown in Fig. 3. As there is a higher pressure on one side of each disk than on the other, it must be steam tight to prevent leakage and strong enough to prevent deflection. The only place where leakage can occur is at the center, where the bore of the hub must be loose enough for a running fit over the hub of the wheel. Annular grooves are turned in the bore to reduce this leakage, on the same plan that grooves are sometimes turned in the surface of a pump plunger for the same purpose. The guide disks are divided on a diametral line, with their top halves bolted to the top of the casing and their lower halves to the base so that the top casing and guides can be lifted off, exposing the wheels, as in Fig. 1. The joints of these disks are ground to a close fit, to prevent leakage.

The casings for the high- and low-pressure parts of the turbine are mounted on the bed plate by brackets placed midway between their ends to prevent distortion from expansion, due to the heat of the steam. There are also large clearance spaces between the guide vanes and wheel blades, made possible by the fact that there is but small tendency to leak at these points, as explained above. This reduces the likelihood of the blades being displaced sufficiently, through the heat of the steam, to cause rubbing when the turbine is running.

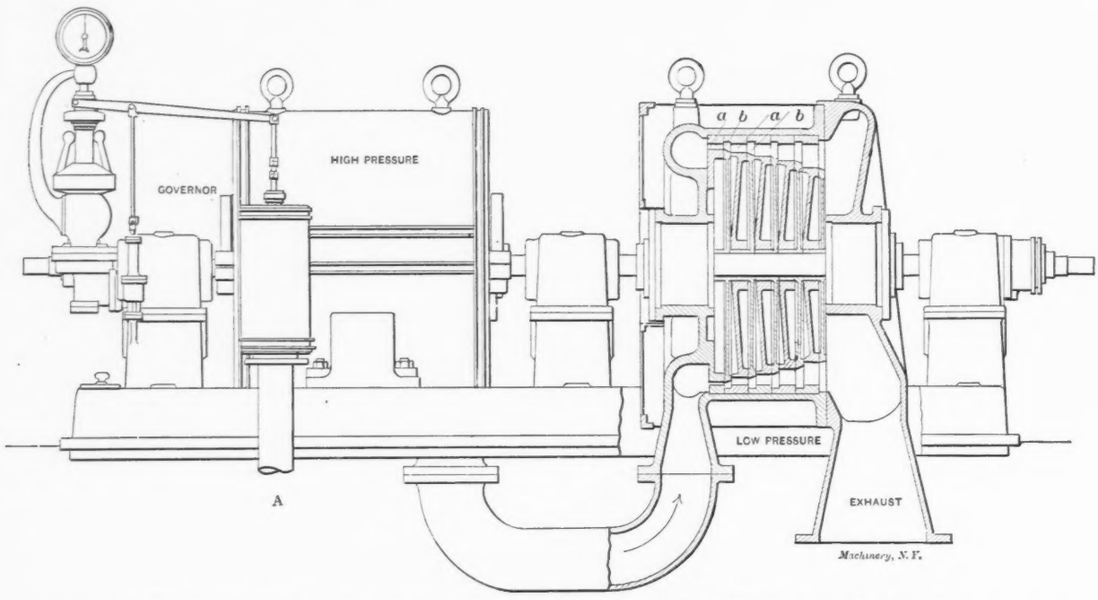

Fig. 2. View showing Section of Low-pressure Turbine; a, a, are Guide Vanes and b, b, Wheel Vanes.

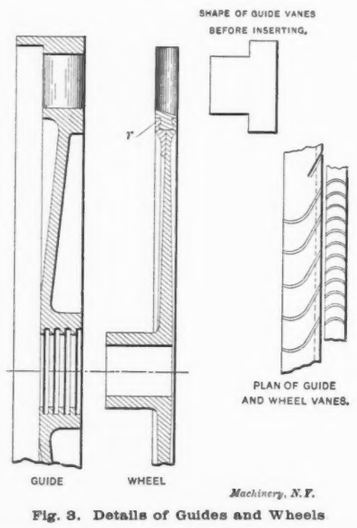

Fig. 3. Details of Guides and Wheels

In Fig. 4 is a detail drawing of the governor, which controls the turbine by throttling the steam. A centrifugal governor acts on a relay valve, *m*, and connects one side or the other to pipes *a* and *b*; *a* being a pipe leading from a reservoir full of a liquid, such as oil or water, under pressure produced by a rotary pump; and *b* a return leading to the suction well of the pump. The two pipes *e* and *f* connect each end of the valve to the cylinder *g*, which is located on top of the main throttle valve. The moving part of this valve is attached to

TESTS ON A ZOELLY STEAM TURBINE OF FIVE HUNDRED BRAKE HORSE POWER.

	Dry Saturated Steam.								Superheated Steam.		
1. Test number	1	2	3	4	5	6	7	8	9	10	11
2. Net power developed in K.W.	363.06	387.65	334.51	240.1	182.22	80.13	.....	.....	391.66	389.6	390.4
3. Revolutions per minute	2967	2967	2977	2983	2984	2995	2995	3000	2972	2973	2968
4. Pressure in steam pipe, lbs. sq. inch, abs	158.7	158.7	155.	156.6	156.	157.	157.	159.1	182.2	186.7	160.1
5. Superheat, degrees Fahr.	.....	.....	.....	.....	.....	.....	.....	.....	135.	153.	109.
6. Pressure, lbs. sq. inch, abs ... After passing through governor throttle valve.	143.6	143.6	128.4	98.4	77.8	43.7	17.3	10.6	138.2	138.2	139.4
7. Superheat, degrees Fahr. ... After passing through governor throttle valve.	.....	.....	.....	.....	.....	.....	39.4	53.	102.	107.	101.
8. Pressure in exhaust pipe, lbs. sq. inch. Steam was saturated	1.02	1.03	0.965	0.934	0.940	0.741	0.725	0.731	0.928	0.944	0.984
9. Vacuum in condenser, inches of mercury	.....	28.5	28.5	28.4	28.3	28.6	28.6	28.5	28.7	28.7	28.7
10. Steam consumption, lbs. per hour	7903	8327	7425	5778	4683	2650	1025	651	7454	7335	7780
11. Steam consumption per kilowatt hour	21.76	21.45	22.19	24.06	25.70	33.07	.....	.....	19.05	18.80	19.80

the same valve stem as the piston *h*, in the cylinder *g*. If the load on the turbine is decreased, the resulting increase in speed raises the governor lever *n*, and valve *m* makes a direct connection between *a* and *f* and *e* and *b*. The liquid, entering cylinder *g*, forces piston *h* down, which closes throttle valve *k* a corresponding amount, reducing the pressure of the entering steam. The valve stem is prolonged and attached to the end of lever *n*, and hence the downward movement of the throttle valve moves the relay valve *m* back to its original position. During this return movement of the valve *m* the lever *n* pivots about its left hand end; while, when the lever was originally moved by the governor, it pivoted about its right hand end. Lever *n* is thus what is called a floating lever, the fulcrum of which is shifted from one end to the other, according to the conditions. When valve *m* has been returned to its original position, no further movement of the throttle valve can occur until the speed of the turbine changes again.

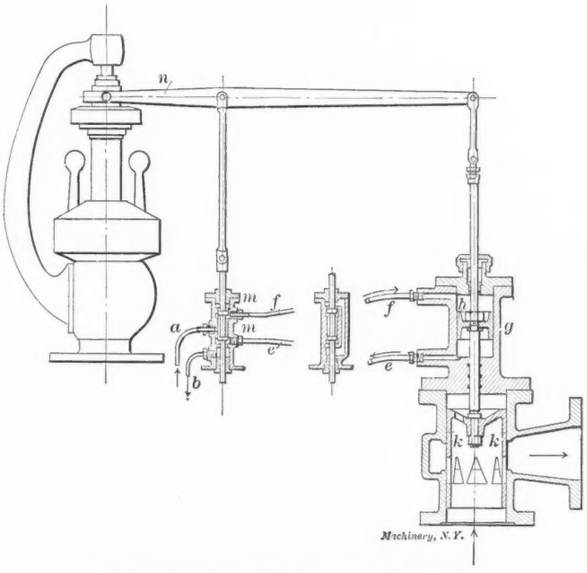

Fig. 4. Arrangement of Governor and Throttle Valve.

A steam turbine of the type described was built at the Zurich works in 1903. The turbine was later tested by Dr. Stodola, professor at the Zurich Polytechnikum and Mr. Wagner of the Zurich Electricity Works. An abstract of the tabulated results is given herewith, with the various units converted into the English system. Every effort was made to provide perfectly dry steam for the tests with saturated steam. The turbine was tested at constant steam pressure but with a gradually decreasing load, regulation of the speed being effected by throttling the steam as it entered the turbine. The superheating indicated in columns 7 and 8, line 7, is due to the steam being throttled by the governor. The last line of the first six columns shows the increase in steam consumption with the reduction in load and the horse power developed in each test is indicated in the second line. The turbine was running unloaded in tests 7 and 8. By comparing the tests with superheated steam with the saturated steam tests it will be seen that there is a gain in efficiency of about one per cent. for every 9 degrees of superheat, Fahr.

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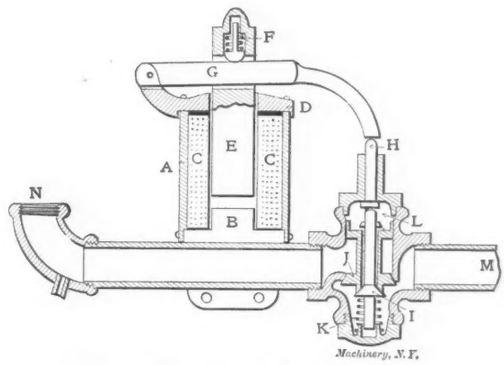
The Electrical Appliance Co., of Cincinnati, Ohio, are making an ingenious device for operating steam whistles. By its use the whistle may be operated from any point in the works, no matter how far distant, and by connecting with suitable



Magnet and Valve for Operating Steam Whistles.

clock-work, it may be automatically blown at stated times.

In the illustration *A* is an iron shell for protecting the magnet winding, *B* the iron base of magnet, *C* the magnet winding, *D* iron cap for magnet, which is also utilized to afford a hinge for the lever *G*, which is actuated by the iron plunger *E*. *H* is a sliding pin which rests upon the stem of the small valve *I*. *J* is a larger valve, and *K* a spring for closing both valves. *L* is an expansion chamber. Steam is supplied through the pipe *M* and the whistle is attached at *N*.

The operation is as follows: The electrical circuit having been closed by pressing a button or automatically by clockwork, *B* becomes a magnet and draws down the plunger *E*, thus depressing lever *G*. This moves pin *H* downward and opens the small valve *I*, with the result that steam is admitted to the chamber *L*, where it aids in opening the larger valve *J*. When the electrical current is broken, the spring *K* causes the valves to close and the various parts return to their first position.

* * *

Very pure iron can be produced by the electrolytic process, the purity being in excess of 99.9 per cent. The impurity consists of hydrogen but this has a most remarkable effect on the product, making it nearly as hard and brittle as glass. Electrolytic iron containing occluded hydrogen can be broken up into grains or can be reduced to a powder in a mortar. But by heating to a white heat the hydrogen is driven off and it becomes soft, having much of the malleability and toughness exhibited by Swedish iron. Pure iron has a very high melting temperature, being about the same as that of platinum, or about 3,200 degrees F.

THE STEAM TURBINE IN A MUNICIPAL STATION—CENTRAL STATION OF THE CITY OF JACKSONVILLE.

The rapid progress made in the rebuilding of the city of Jacksonville made necessary the consideration of extensions to the city electric plant to satisfactorily meet increasing demands for electric light and power.

As the available space was limited and the cost of foundations for reciprocating engines would have been a large item, owing to the character of the soil, the merits of the steam turbine as a prime mover, were given careful consideration.

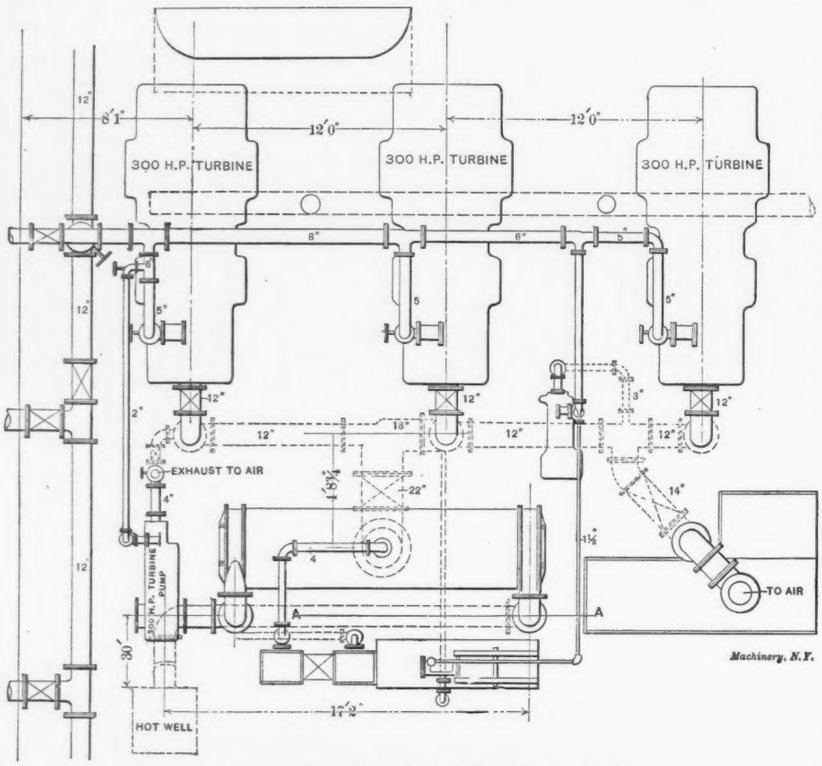


Fig. 1. Plan of Part of Station where Turbines are Located.

It was finally decided to place two 300-horse power De Laval steam turbines, direct connected to two 200-kilowatt Bullock three-phase, 2,300-volt twin alternators designed for 7,200 alternations per minute. Two 350-horse power Babcock & Wilcox boilers, Alberger condenser and other necessary accessories were installed. It was later decided to place an additional 300-horse power De Laval steam turbine, direct connected to a 200-kilowatt, 500-volt, direct-current generator. The entire contract was assumed and executed by the D'Olier Engineering Company, Philadelphia.

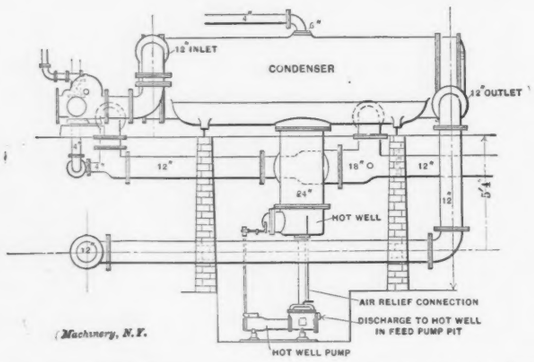


Fig. 2. Elevation of Condenser and Hot Well; Section on line A A above.

The plant is located near the center of the city, the lines extending about one mile north, one and one-half miles to the east, two miles to the southwest and one-half mile to the west. Alternating current is furnished for lighting and direct current is furnished over an area of about two square miles for elevator motors and other power service. The general layout of the additional plant installed is shown in Fig. 1.

The two Babcock & Wilcox boilers are operated under natural draught, a steel stack 100 feet high and 60 inches in diameter being used. The boilers are connected to the main steam header which also connects to the old boiler plant. A working pressure of 200 pounds is maintained and each boiler is equipped with a Babcock & Wilcox superheater, which produces steam superheated about 100 degrees Fahrenheit when boilers are operated at their rating. The high pressure and superheat combined are especially applicable for steam turbine service.

Fig. 3 is a view of the turbines from the steam end. The old plant will be noted in the background. The small pipes leading to the end bearings of the turbines supply water to water jackets for cooling the bearings. The high-speed bearings are all lubricated from a central oil tank which feeds the manifold sight-feed lubricator on each turbine. The steam turbine exciter is shown between the two alternators. Fig. 4 shows the steam turbine pump used to supply circulating water; also the steam condenser and vacuum pump in the foreground. It will be noted that steam turbines are used exclusively as prime movers in this part of the plant excepting for the vacuum pump.

The Alberger condenser used is guaranteed to be capable of condensing fifteen thousand pounds of steam per hour and to maintain a vacuum of 28 inches with barometer at 30 inches; and under these conditions the plant is operated on a most efficient basis.

The alternating-current switchboard is constructed of Tennessee marble, consisting of three panels supported on angle iron frame. Each generator panel is provided with three ammeters, voltmeter, rheostat, combined oil switch and circuit breaker and necessary synchronizing device.

The complete plant, with the new additions consists of the following apparatus: Four Babcock & Wilcox boilers of 350 horse power each and one Caldwell boiler of 350 horse power; one Filer-Stowell Corliss cross-compound engine of 750 horse power, and two Hamilton Corliss tandem compound engines of 350 horse power each; four General Electric monocyclic generators, two of 150 and 200 kilowatts respectively, and two 250 kilowatts each; three No. 11 Brush arc dynamos with a capacity each of 125 lights of 2,000 candlepower; one direct-current 150-kilowatt, 500-volt generator; two 300-horse power, 200-kilowatt De Laval turbine alternating-current generators and one 300-horse power, 200-kilowatt De Laval turbine direct-current generator with condensers and auxiliaries.

The plant is owned by the city of Jacksonville and is under the supervision of the Board of Trustees for the Water Works and Improvement Bonds.

* * *

So many nut-locks have been patented that it is difficult to say what is new in this line. What is supposed to be a new idea, however, was recently patented in Great Britain. The nut is not faced off squarely on its base but, instead, is provided with an arched or angular base, the point of the arch or angle coinciding with a medial line through the base. Two saw cuts are made in opposite sides of the nut, at right angles to the hole, until they nearly meet. When the nut is screwed up tightly, the arched base flattens, closing the saw cuts at their outer edges and, consequently, pinching the threads. The trouble with this and similar inventions in the nut-lock line is that they work fully as effectually in preventing the nut being set up tightly as in stopping its working loose. A simple and effective nut-lock is another nut.

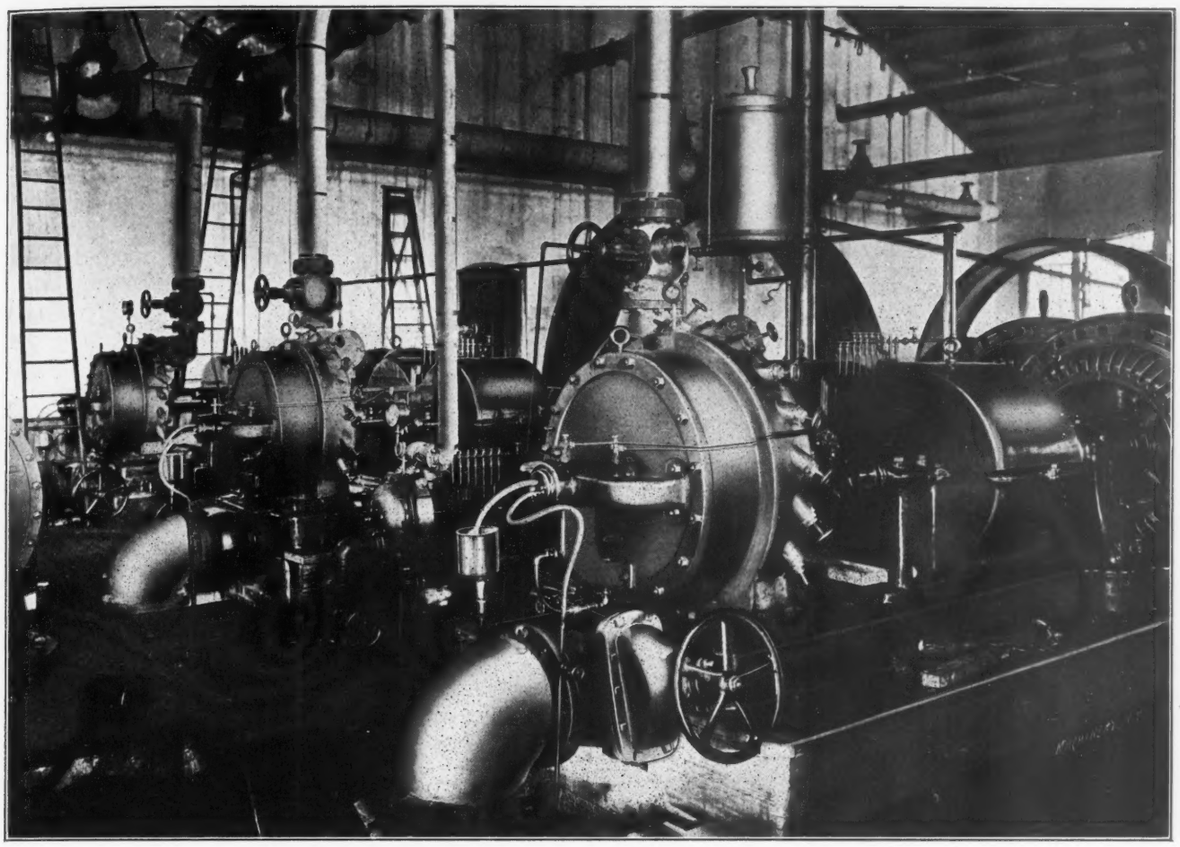


Fig. 3. View of De Laval Turbines in the Central Station of the City of Jacksonville.

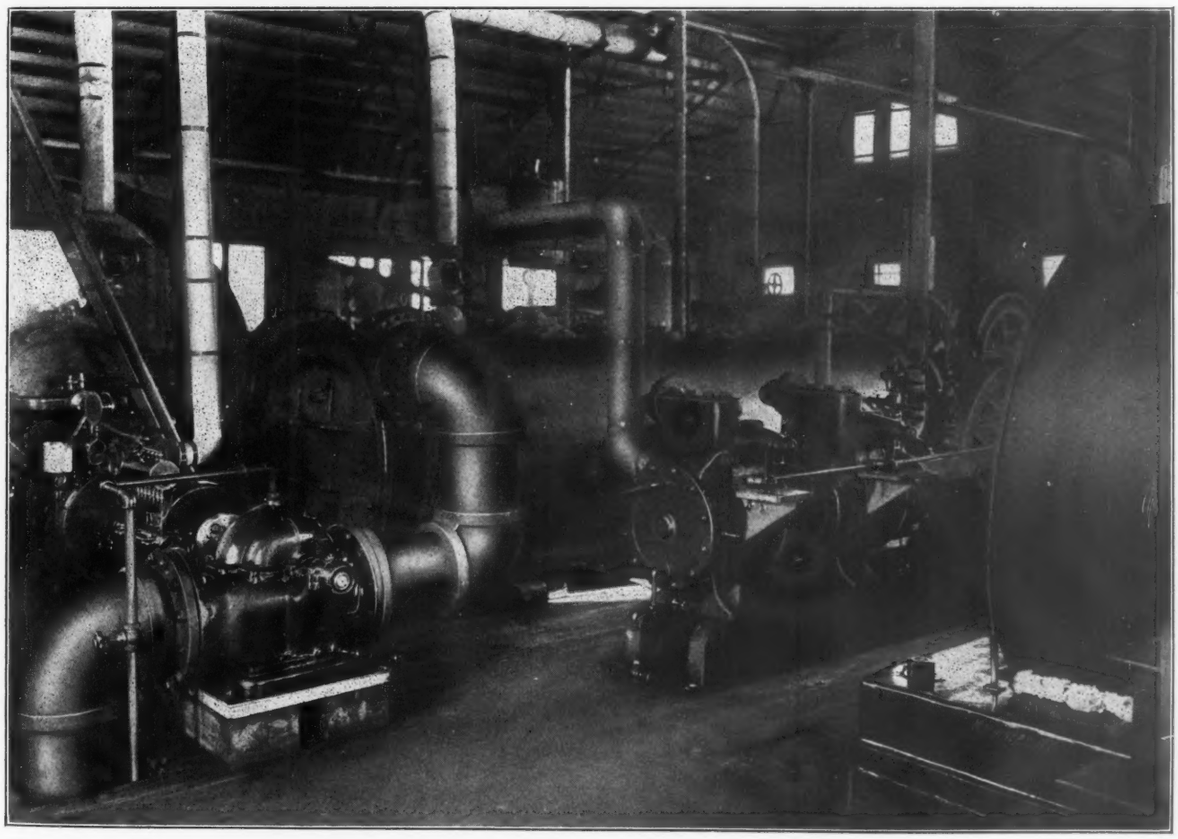


Fig. 4. View of Condensing Apparatus showing large size of Condenser required.

VARIABLE SPEED MOTORS.—5.

THE BULLOCK THREE-WIRE SYSTEM.

WM. BAXTER, JR.

As we have already explained in previous articles of this series, the size of motor required to do a given work depends upon the amount of speed variation; the greater the variation the larger the motor. The size of the motor, however, is also dependent upon the way in which the speed variation is obtained; for example, to obtain a variation of, say, four to one by field regulation alone will require a considerably larger motor than would be necessary if the voltage acting on the armature were also varied. It is for this reason that three- and four-wire systems have come into use. If by means of these systems the size of the motor could not be reduced, they would not be used, as the simple field regulation is less complicated and expensive; but owing to the reduction in the size of the motors, it is found that the saving made in this direction more than offsets the greater cost and complication of the multi-voltage systems.

The four-wire system renders it possible to obtain a range of speed variation of 6 or 7 to 1, without using unreasonably large motors; but experience has shown that in most cases, a range of 4 or 5 to 1 is all that is required, and this can be readily obtained by means of the three-wire system in connection with field regulation, the motors remaining about the same size as for the four-wire system with wider speed variation.

The Bullock Company uses a three-wire system for all cases where the speed range required is not much more than 5 to 1. In this system the voltages between the middle and the side wires are not equal, and as a result three different E. M. F.'s. are obtained. Thus with a maximum E. M. F. of 250 volts, the voltages between the center and the side wires are 90 and 160, which makes the lowest E. M. F. about 36 per cent. of the highest; the actual ratio being about 2.8 to 1. It is easy to make motors that can give a speed variation of 2 to 1, without being unreasonably large; hence, with such motors and a three-wire system, with the voltages above named, the speed variation will be 5.6 to 1.

The Balancer for the Three-wire System.

The balancer used by the Bullock Company for the three-wire system, as well as that for the four-wire, is provided with compound wound fields; and these, by acting differentially on the machine that runs as a motor, and cumulatively on the machine that acts as a generator, control the voltages so as to maintain that acting on the motor constant, or practically so, for all changes in the strength of armature current. The arrangement of the field coils can be readily understood from the diagram, Fig. 7, in which *A B* represent the two machines that constitute the balancer, *A' B'* being their armatures. The lines *P O N* constitute the distributing mains, with which the motors are connected, the leads from the generator being connected with *P* and *N*. The arrow heads show the direction of the currents when the machines are both acting as motors, but when either one of them acts as a generator the direction of the current through its armature and series field coils is reversed. As will be seen, the main current after passing through the armature *A'* enters the series field coils at *c*, and comes out at *d*. It then passes to machine *B* and after traversing the armature *B'* enters the series field coils at *c'*, and passes out at *d'*.

The shunt field circuit of machine *A* starts from line *P* at *e*,

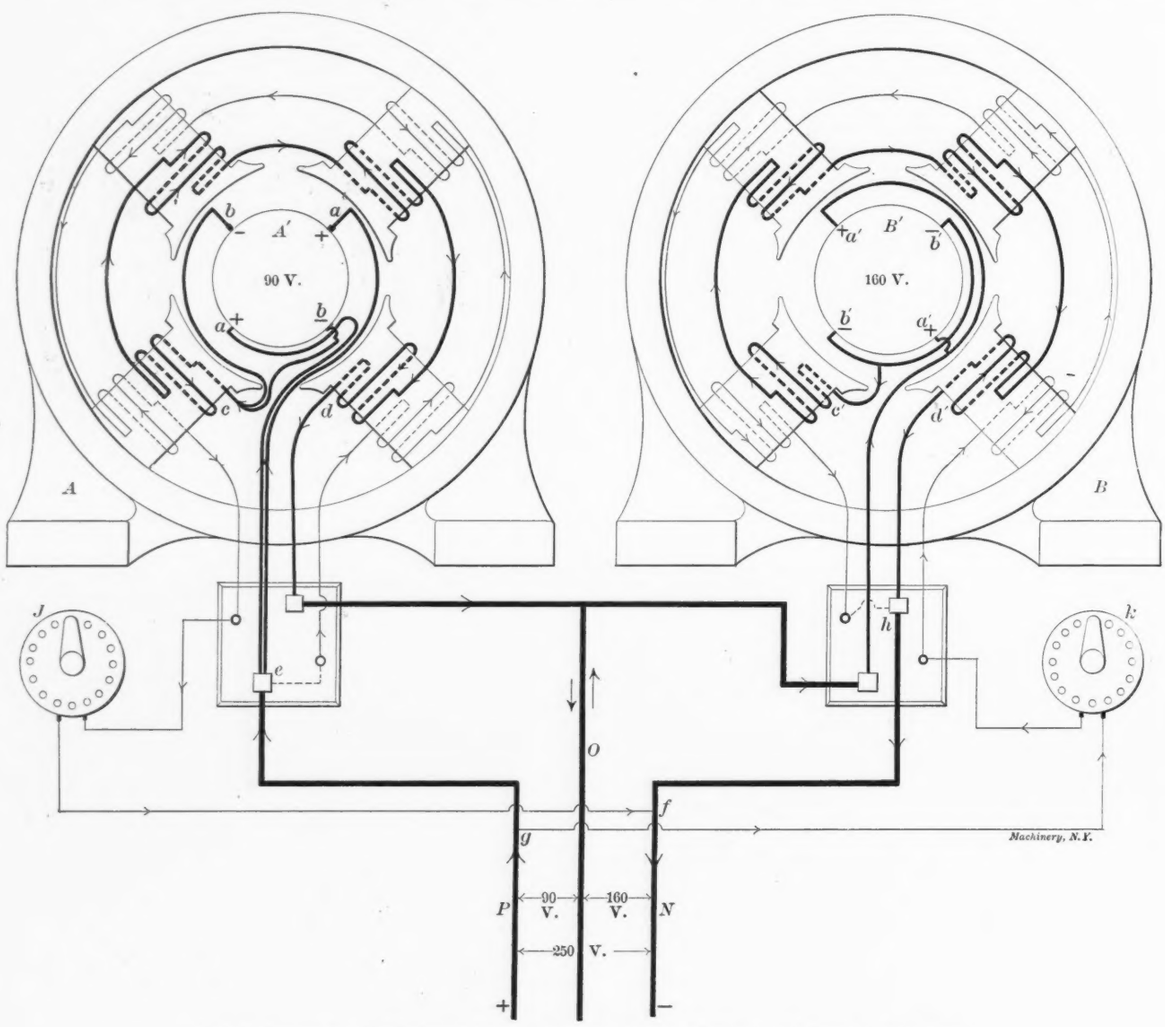


Fig. 7. Diagram showing Balancer for the Three-wire System of the Bullock Electric Mfg. Company.

and runs to line N at f. By looking at the arrow heads on the shunt and series field coils of this machine, it will be seen that the currents in the two run in opposite directions, so that the series coils act in opposition to the shunt coils. The shunt field circuit of machine B, branches from P at g, and enters N at h, and in this machine, as will be seen by looking at the arrow heads on the fields, the currents in the shunt and series coils flow in opposite directions, so that the series coils act in opposition to the shunt, the same as in machine A. At J a field rheostat is provided to regulate the shunt field current of machine A, and at k is another field rheostat to regulate the shunt field current of machine B.

From the foregoing it will be seen that when both machines, A and B, act as motors, the action of the series field coils is differential. When either one of the machines acts as a gen-

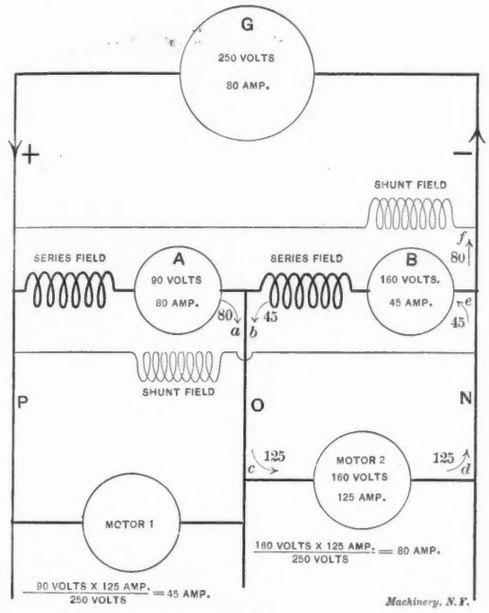


Fig. 8.

erator, the direction of the current through its armature and series field coils is reversed, and then the series coils assist the shunt coils, that is the action is cumulative. The way in which this reversal of the current in the series field coils acts to keep the voltage constant can be more clearly explained by the aid of the simple diagram, Fig. 8.

Principle of Operation of the Balancer.

In Fig. 8, G represents the main generator, and the circles A B are the armatures of the two machines that constitute the balancer. The shunt coils magnetize the fields of the machines, and the series field coils demagnetize them to a certain extent, that is, when the current flows through the armatures from P toward N. The velocity at which an armature will rotate depends upon the strength of the field. The stronger the field the lower the speed. The E. M. F. developed in an armature depends upon the strength of the field and the velocity of rotation. The stronger the field the higher the E. M. F.; and the higher the velocity, the higher the E. M. F. In other words, increase in field strength, and increase in speed, both act to increase the E. M. F. of a generator armature. The E. M. F. developed by a generator armature is not all available outside the machine; a portion of it is expended in overcoming the armature resistance, and this portion increases with the strength of the current, so that the stronger the current the lower the net E. M. F. In a motor a portion of the E. M. F. of the current that passes through the armature is absorbed in overcoming the resistance of the wire, the balance of the E. M. F. is balanced by the counter E. M. F. developed in the motor armature, so that the speed of the latter must be just enough to develop this E. M. F., and no more. If the current passing through the motor armature is increased, the portion of the E. M. F. absorbed by the resistance of the wire will be increased, and as a result the velocity of the armature will be reduced.

Keeping these facts in mind it can be seen that if the armatures A B were acted upon by the shunt field coils only, the one acting as a motor would decrease in velocity if the current increased, and the one acting as a generator would give a reduced net voltage if the current increased. The reduction would be due not only to the greater loss of voltage within the armature, but also to the reduction in speed; for it must be kept in mind that the armature that acts as a motor drives the other one. When the two machines are provided with series field coils, if the current through the armature of the one that is acting as a motor increases, the differential action of its series coils will also increase, thus weakening the field and causing the armature speed to increase. The other machine, acting as a generator, will have its field increased, because the direction of the current through the series coils will be reversed, and this increase in field strength, together with the increased velocity, will result in an increase in the voltage of the current generated.

By properly proportioning the series field coils, the increase in speed as well as the increase in the field strength of the machine that is acting as a generator can be made just sufficient to off-set the increased loss of voltage in overcoming the resistance in its armature, so that the net E. M. F. will remain constant.

Comparative Action of Shunt and Compound Wound Balancer.

In Fig. 8 if a motor is connected in the circuit in the position marked "Motor 2," the balancer machine A will act as a motor, and B will act as a generator. Suppose the balancer is shunt wound, that is, that the series field coils are removed, then the strength of the fields of the two machines will remain constant regardless of what the current through Motor 2 may be. Let us suppose the current through Motor 2 is 12½ amperes; then there will be 8 amperes flowing through A and this machine acting as a motor will drive B and cause it to generate a current of 4½ amperes. These figures would be correct if we made no allowances for losses within the armatures of A and B. The current of 8 amperes flowing through A would cause it to revolve at a velocity that would develop a counter E. M. F. of very nearly 90 volts, and this velocity would be sufficient to enable B to develop a voltage of a little more than 160, so that deducting the portion absorbed by the armature resistance, there would be a net E. M. F. of 160 volts to act on Motor 2.

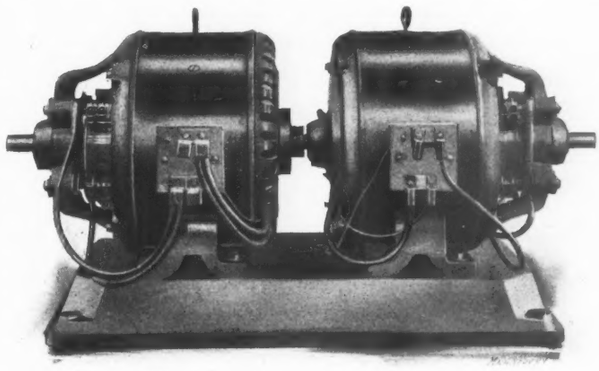


Fig. 9. Bullock Three-wire Balancer.

Now if the current through Motor 2 is increased to 125 amperes that through A will become 80 amperes and that through B will be 45 amperes. With these currents, A will run considerably slower, and as a result the E. M. F. developed by B will be reduced, while the portion thereof that will be absorbed by the armature resistance will be ten times as great as before, so that the net voltage acting on Motor 2 will be considerably below 160.

If the two balancer machines are provided with series coils, the action will be considerably modified, because the current flowing through the coil of A will act in opposition to the shunt field coil, while the current flowing through the series coil of B will act with the shunt field coil. Owing to this difference, the field of A will be weakened and, therefore, the armature will run faster, while the field of B will be strengthened and this increase in field strength, together with the higher speed

will cause the machine to develop a higher voltage. If the current passing through Motor 2 is 12½ amperes, the speed and the E. M. F. developed in *B* will not be much different from what it is shown above to be with the simple shunt field; but if the current is increased to 125 amperes the speed of *A* will be materially increased, and the field of *B* will become much stronger, so that the voltage developed by *B* will be sufficient to overcome the increased loss within its armature and still leave a net E. M. F. to act on Motor 2, equal to that obtained with the weaker current. By properly proportioning the series coils each machine can be made to develop a net voltage that is practically the same for all strengths of current passing through the motor, whether the latter is connected in the position of Motor 2 or Motor 1.

Size of Balancer Required for a Given Service.

In Fig. 8 it will be noticed that the current passing through armature *A* is a trifle less than two-thirds of that passing through Motor 2. If the motor were connected between lines *P* and *O*, the current through *A* would also be 80 amperes. In the first case, *A* would draw its current from the generator *G* and acting as a motor would drive *B*, causing it to generate a current of 45 amperes. In the second case, *A* would act as a generator and would deliver a current of 80 amperes, and *B* would act as a motor and draw 45 amperes from generator *G*. In both cases it will be seen that the maximum current passing through the balancer is about two-thirds of that passing through the motor.

If Motor 1 and Motor 2 are both in service, and both take the same current, no current will pass through the balancer except the small amount necessary to keep the armatures rotating at their normal velocity, and this would be only a few amperes. From this it can be seen that the balancer must be of sufficient size to furnish a current equal to the difference between that required by the motors connected on opposite sides of the middle wire. If only one motor is in use, the current capacity of the low-voltage armature of the balancer can be two-thirds of that of the motor. If a number of motors are in use, the current capacity of the low-voltage armature need not be much in excess of that of the largest motor, because the load on one side of the center wire *O* is not likely to differ from that on the other side by an amount greater than this. The greater the number of motors in use, the smaller the size of the balancer relative to the total capacity of the motors.

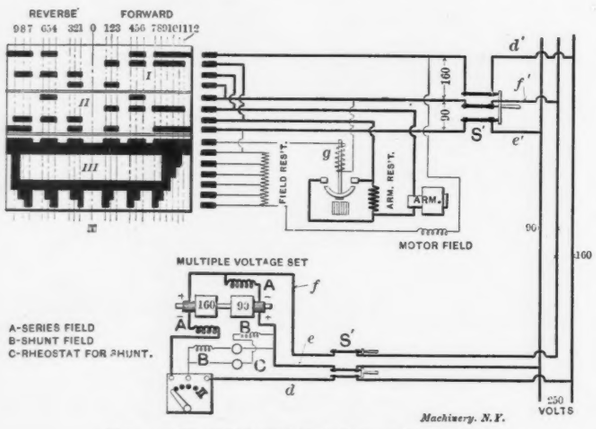


Fig. 10. Controller used with Three-wire System.

The design of the three-wire balancer of the Bullock Company is shown in Fig. 9.

The Controller for the Bullock Three-wire System.

The controller used with the three-wire system is shown, diagrammatically, in Fig. 10, in which the lower part represents the balancer and the upper part the controller, the motor and the connections between the two. This diagram is so simple that it will need but a slight explanation. The drums marked I, II, III, shown in the upper left-hand corner, are mounted on the controller cylinder, and as in the four-wire controller are metallic casings surrounding the cylinder, the dark portions being raised so as to make contact with the row of stationary contacts which are shown at the right side of the drums. The true position of these stationary contacts when the controller is in the stop position, is along the center vertical line *x*. The two upper drums are for the purpose of connecting the armature terminals of the motor with the lines *d'*, *e'*, *f'*, so as to change the connections from the 90 to the 160 and finally to the 250 volt lines. The controller gives 12 speeds forward, and 9 when reversed. On the first speed the motor armature is connected with the 90-volt lines, on the 4th speed it is connected with the 160-volt lines and on the 7th speed it is connected with the 250-volt mains. The lower drum is for the purpose of cutting the field resistance in and out of the circuit. The field resistance is all cut out on the first, fourth and seventh

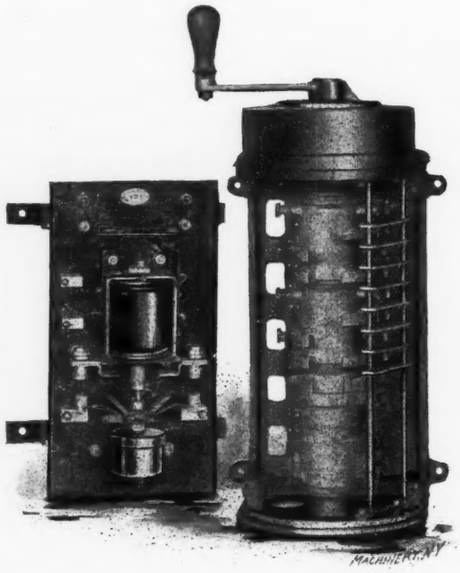


Fig. 11. Fig. 12.

steps. On the second step one section of the field resistance is cut in; on the third step two sections are cut in. On the fifth and sixth steps one and two sections, respectively, are cut in. From the eighth to the twelfth steps all the sections of the field resistance are cut into the field circuit, one after the other.

The motor is started with a resistance in the armature circuit, and this is cut out automatically by an electro-magnetic switch *g*, which is provided with a retarding device that can be adjusted so as to close the switch in whatever interval of time may be necessary. This switch is shown in the half-tone, Fig 11. The controller proper is shown in Fig. 12.

* * *

A certain industrious correspondent living near Boston runs a manuscript mill that must work day and night, judging from the number of his articles one sees in many of the reputable technical journals. While his articles are well gotten up and neatly typewritten, they are in most cases absolutely worthless, being fakes of the most transparent order. They all have certain characteristic earmarks, and many of them tell of weird ways and methods of making repairs on any machine, including automobiles, electric motors, telephones, machines, etc. A favorite graft since the Spanish-American war has been alleged letters from an ex-soldier telling of the mechanical devices used by the Filipinos, many of which are undoubtedly without parallel on earth or any other place. Within the past six months two of the leading electrical journals have published his articles, one of which tells of the alleged uses of rawhide in the Far East. We are solemnly told that rawhide washers on electrical devices are a failure except when thin metal washers are used on top. Why in the name of common sense does any one want to use rawhide washers on electrical devices or any other devices One cannot help admiring the versatility of this gentleman. His talent is certainly of no mean order, although prostituted in the hoaxing of editors. We have found his work in electrical, mechanical, automobile, sporting, literary, and even in theological journals, in which latter case he posed as a "reverend."

MODEL PLANT OF THE NEW BRITAIN MACHINE COMPANY.

As a model example of the mill type of construction, applied to machine shop use, we show in this number several views and drawings of the recently completed works of the New Britain Machine Company, New Britain, Conn. This plant, conveniently located with respect to freight and passenger stations and local trolley lines, is of brick, with four stories and basement. The multi-storied construction became necessary owing to the cost of land in the location above, convenient to other shops and central with respect to a local jobbing trade. Under similar circumstances the plan of the works would be available for any general machine shop employing from 100 to 200 hands on medium and light work, using 38,000 square feet floor area. Being of the mill type, however, its various features can be applied to similar buildings, whether larger or smaller, since the main difference between a large and small building of this character lies in its length and the number of its floors.

Apart from being an excellent example of mill construction, the plant is of interest because of its equipment and arrangement. One of the chief products of the New Britain Machine Company is a line of shop furniture, consisting of metal racks, lathe pans, stationary and portable shelves, etc., all of which are conducive to the convenient handling and orderly storing of stock, small tools and machine parts. This "furniture" is much in evidence in this plant, as a matter of course,

FIG. 1. GENERAL VIEWS OF THE NEW BRITAIN MACHINE COMPANY'S PLANT.

A. Building.
B. Secretary's Office.
C. Sales Manager's Office.
D. Superintendent's Office.
E. View of Second Floor.
F. Assembling Room.

adding to its attractiveness; but it comprises only one of many mechanical niceties that have been introduced and which appeal strongly to the systematically inclined.

Mr. R. S. Brown is secretary and mechanical engineer of the New Britain Machine Co., and we are indebted to him for

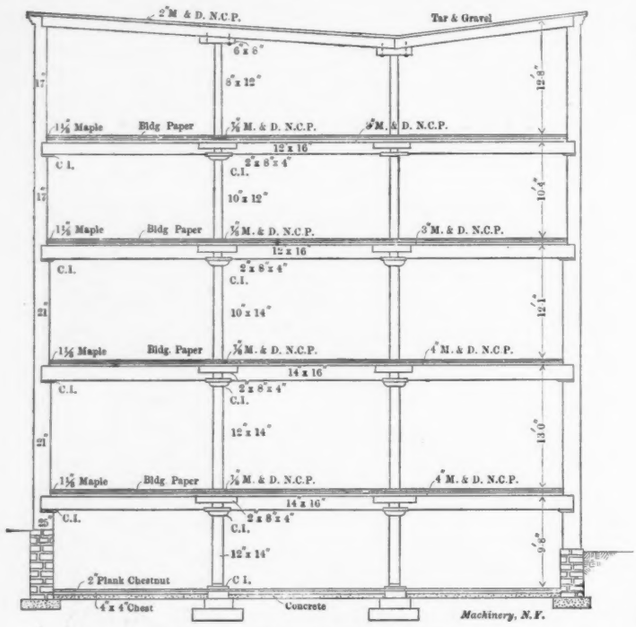


Fig 2. Cross-section of the Building.

the following description, which explains many interesting details about the plant and its equipment.

Outside, a pleasing effect is given to the building by the use of round-cornered brick on all external corners; this is thought to help a little, also, in letting in better light by the corners of the pilasters. These pilasters are carried straight up to the roof, and the diminution of thickness of wall from bottom to top, as indicated in the sectional sketch, Fig. 2, gives increased floor space on the upper floors.

At the front of the building, which is the left-hand end in Fig. 1, are located the offices, drawing rooms and also a fireproof vault which extends up from the basement through three stories. The offices are separated from the manufacturing part of the building by a brick fire wall. The introduction of this wall did not cost as much as was saved by the lighter timbering possible under the offices, as against the cost of standard heavy mill construction for this part of the structure. The effect of the wall, of course, is to practically insulate the offices from the jar and noise of the factory.

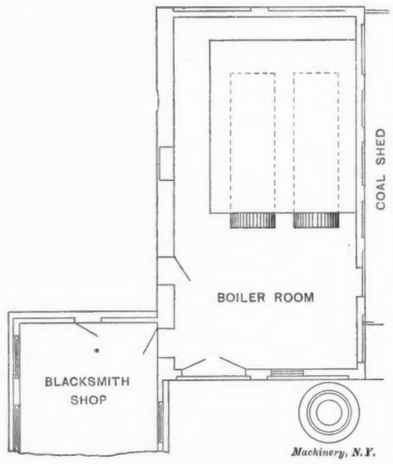


Fig. 4.

The opposite or east end of the building has been sheathed temporarily with planking and iron, and it is planned to extend the building at this end when the growth of the business demands it. When this is done the elevator, outside stairs, the closets, the power, tool room, etc., will all be at the middle of the completed building, and thus involve the least amount of travel for each operative.

In Fig. 3 is a plan view of the basement, where are located the wash rooms, racks for clothing, and where the engine testing and assembling of different lines of machinery are carried on. The workmen enter the building through the door near the west end, at the left. They have the advantage of a large wash room and individual hooks, etc., for clothes. Passing through a turnstile, as shown, the time clock is

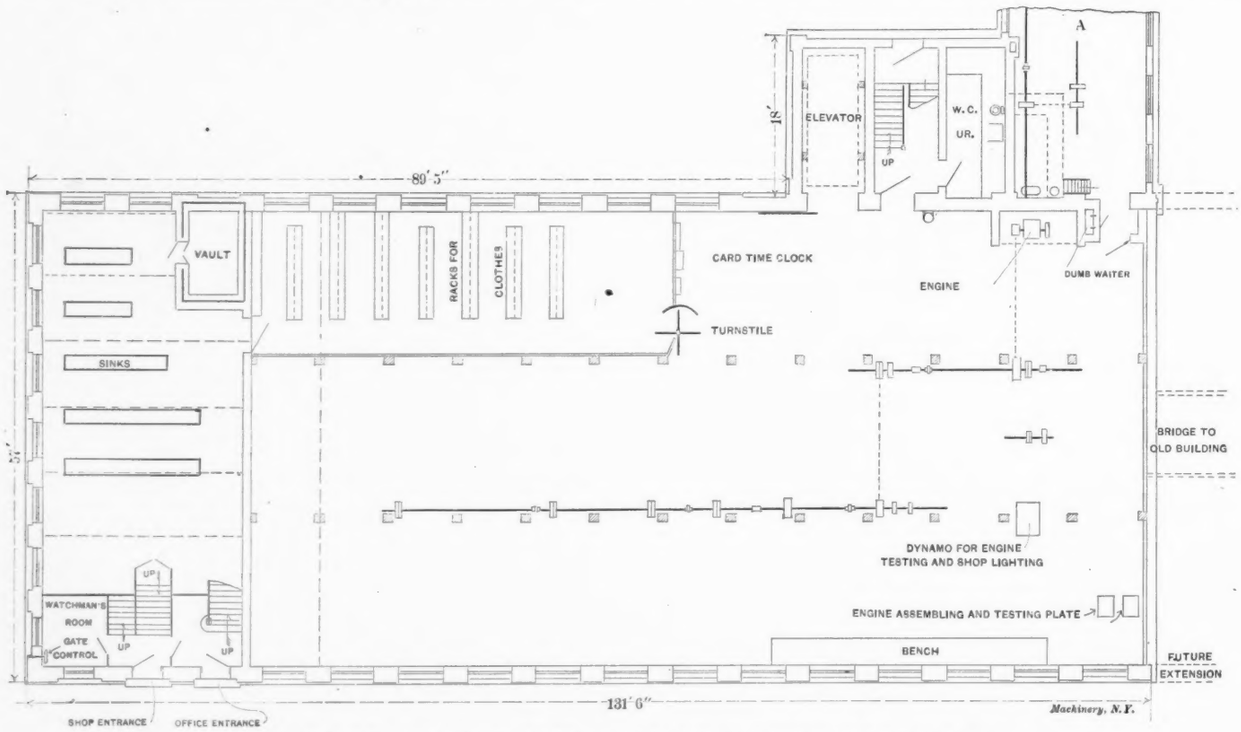


Fig. 3. Plan of Basement. Workmen's Entrance at the Left, where are located the Wash Rooms.

reached. The turnstile can be locked against backward rotation and the coat and hat room thus made inviolate. By changing the lock the turnstile is left free to rotate in the opposite direction, but prevents unauthorized entrance into the building during the noon hour or at other times.

At the top in Fig. 3 will be noted the location of the stairs and elevator, which latter is of unusual proportions, 16 by 6 feet, with a capacity of 3 tons. This size was chosen with the idea of carrying lumber, shafting, steel, etc., in commercial lengths when lying flat on the car; and although somewhat large for rapid traveling, it is found that by counterbalancing on both the car and the drum, it works very easily. The outside door of the elevator being level with the ground greatly facilitates loading and unloading, and is particularly handy in the case of automobiles needing repairs.

The blacksmith shop, indicated in Fig. 4, connects with the basement at point *A*, Fig. 3. A dumbwaiter, shown in the upper right-hand corner of Fig. 3, runs from the entrance of the blacksmith shop to each floor above and is largely used for conveying tools to be dressed or light work to and from the smiths. Speaking tubes are beside it, and the intention has been to provide all conveniences for the workmen right on the floor where employed, so there is no occasion for traveling to other floors.

At the left of the dumbwaiter in Fig. 3 is shown the location of the engine which furnishes power for the basement.

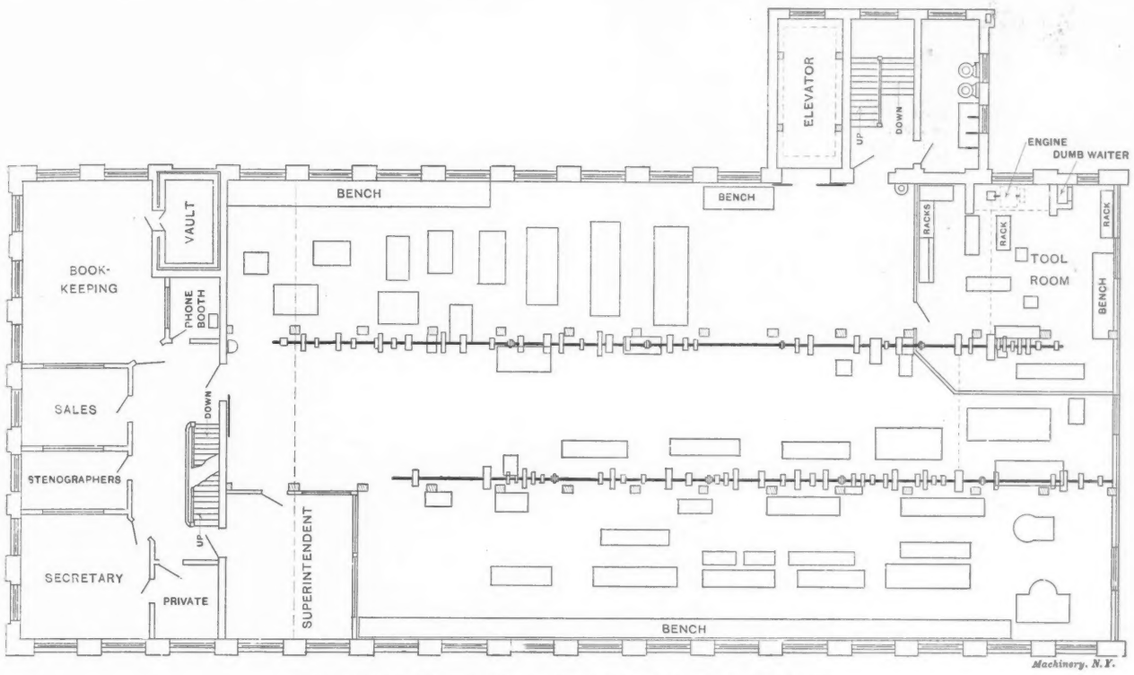


Fig 5 Plan of Second Floor, where are located the Business Offices.

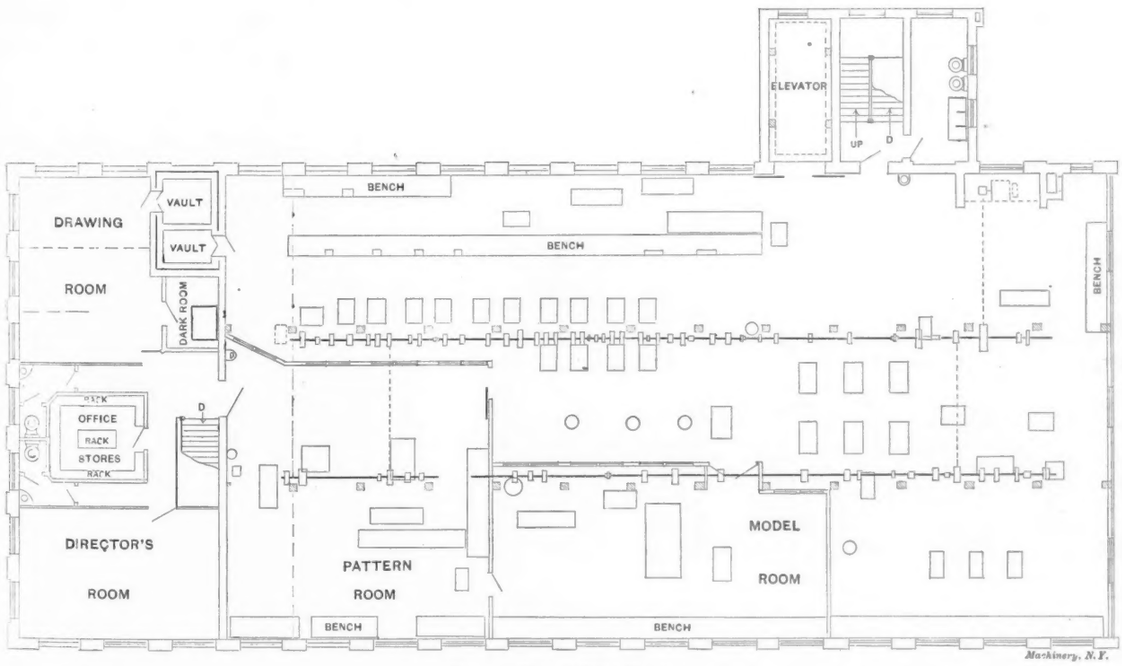


Fig 6. Plan of Third Floor.

This company manufacture the Case vertical steam engine, and have placed one of their machines, of 25 horse power, on each floor, to supply the motive power for that floor. This plan lends itself to the individual needs of each department with all the flexibility of motor drive and the possibilities of change in the speed in any department by a slight change in the governor of the engine. All belt holes in the floor are thus avoided. For supporting this engine two piers or wing

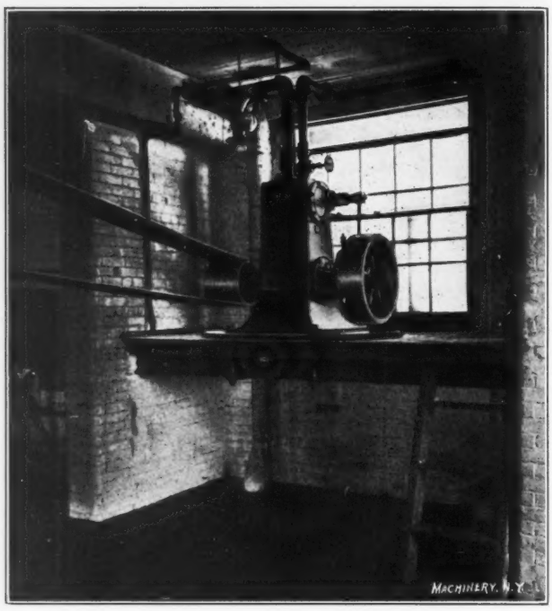


Fig. 7. One of the "Case" Engines used for Power.

walls are carried up through the building, and steel I-beams laid into the piers at the proper height above each floor, the engine being located high enough to give head room under the driving belts. The illustration, Fig. 7, shows one of these engines as mounted in its position in the factory. The exhaust from each engine goes into a return riser, passes through a feed-water heater in the basement and then to the roof, where, in the winter time, it is turned into the heating system. This system of driving has been complimented many times by visiting engineers.

The three lower floors of the main building were designed for a load of 400 pounds to the square foot, without undue deflection, and the two upper floors for 300 pounds to the square foot (see Fig. 2). The use of heavy cast-iron saddles to carry the floor girders, as shown clearly in Fig. 1, *F*, permits posts to be placed end to end, and so constitute a solid post from foundation footings to roof. With the comparatively slight shrinkage of wood in the direction of its length there is but little change throughout the whole post, and hence this can be used for fastening post hangers to carry the lines of shafting with a minimum of annoyance from changes in alignment, and changing loads upon the floors do not affect the shafting.

In designing the saddles care was taken to have the supporting flanges come underneath the plates upon which the floor beams rest, so as to leave the relatively large plate in tension, and the supporting brackets, which are smaller in cross section, in compression, thus adapting their design to the characteristics of cast-iron, of which they are constructed. Inasmuch as the posts pass through the floor, provision must be made for supporting the floor around the posts, and spiking pieces consisting of strips of plank are nailed on the sides of the girders at their abutting ends for this purpose. These strips are visible in Fig. 1, *F*, directly over the saddles at the top of the columns.

Up one-and-a-half flights, and separated from the shop by the fire wall, are the offices of the company. Their plan is clearly represented in the second floor plan in Fig. 5. The main rooms occupy the whole front of the building and comprise offices for the bookkeeping department, the sales department, the stenographers and the secretary. These individual rooms secure to each department the proper degree of privacy, yet, by a system of windows between, as indicated in the plan and shown in the two views in Fig. 1, *B* and *C*, a view may be had of the different apartments from any one room, and a proper oversight kept. The offices are finished in dark wood wainscoting and burlap to harmonize.

The superintendent's office, Fig. 1, in the southeast corner of the machine room on this floor, opens into the general suite through the fire wall. It also is supplied with generous window space on shop sides, so that it commands a view of the entire machine room.

In the office system liberal use is made of the card index in keeping records, the large omnibus of information cards being the principle assistance of the sales manager, and shown in the illustration of his office, Fig. 1, *C*, where it is daily wheeled from the vault.

The shipping room is on the first floor under the offices, and is thus divided from the shop by fire wall. Here is kept a stock of finished goods, so that a fire on either side of the wall will not entirely upset business; for on one side are the finished goods, and on the other side, at all times, goods partly completed. The floor being just the same distance from the ground as the average wagon bed, makes the loading of machines or merchandise exceedingly easy.

On the floor over the main offices are the drawing room, the directors' room and a store room for office supplies. The drawing room is so located as to receive a north light. A large dark room is a convenience enjoyed by the blue printer, and shared by him with the photographer.

On all repetition work the company's blue prints are 11 x 14 in size. They are mounted on fiber board about 1-16 inch thick, and given two coats of white shellac varnish. The edges

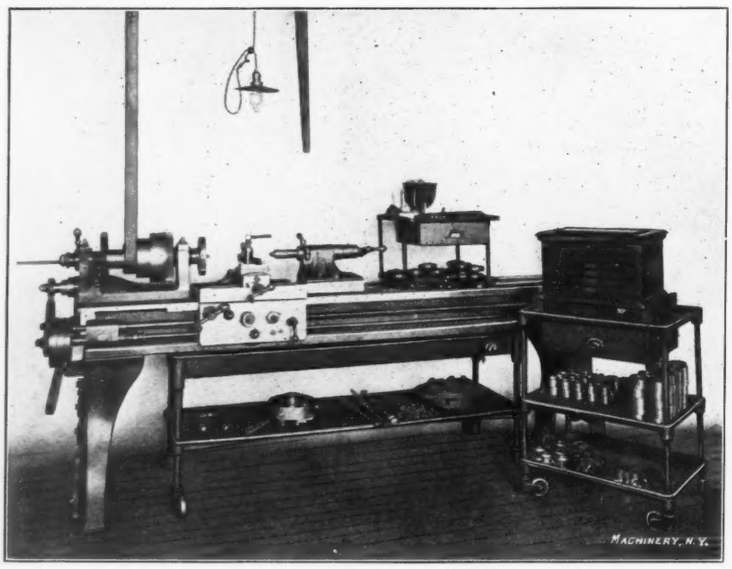


Fig. 8.

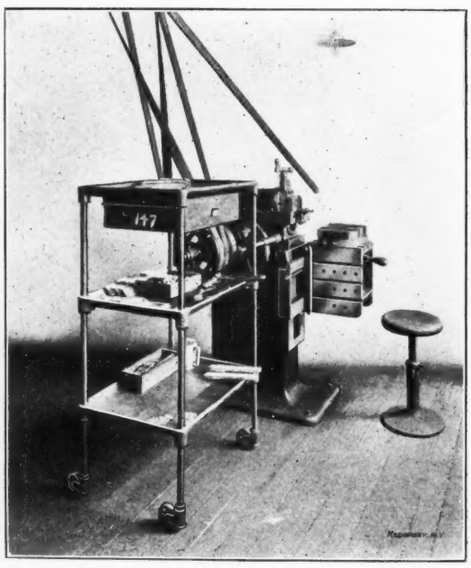


Fig 9.

All the Machine Tools in the Shop are Equipped with the New Britain Machine Company's "Shop Furniture."

of the prints have a tin binding to prevent fraying, and the insertion of a grommet at the top makes a durable eyelet to hang these up by. Prints so mounted ten years ago are in good condition to-day, although worked from continually as the job has been repeated during that time.

In the office stock room, in which are stored the supplies of printed matter and office sundries, boxes are provided in which all printed matter and supplies are packed, thus keeping them fresh and free from dust. A careful card record is kept of the contents of each box, so that when it is desired to find a given article or printed form, it is only necessary to turn to the card to secure information as to the number of box in which the article wanted will be found.

The fireproof vault, which extends up from the basement through three stories, is built into and made a part of the west wall and fire wall previously mentioned. Located thus, use can be made of the fireproof storage on either side of the wall as may be desired. This will be seen in plan of third floor, where it was thought best to divide the vault, as shown, so that half is used for the drawing room for safe keeping of tracings, and half accessible from shop for small tool storage.

The grouping of the general offices, superintendent's office, drawing, pattern and model rooms will be noted as convenient with respect to frequent consultation and close watching of new work in its various stages from conception to finished articles.

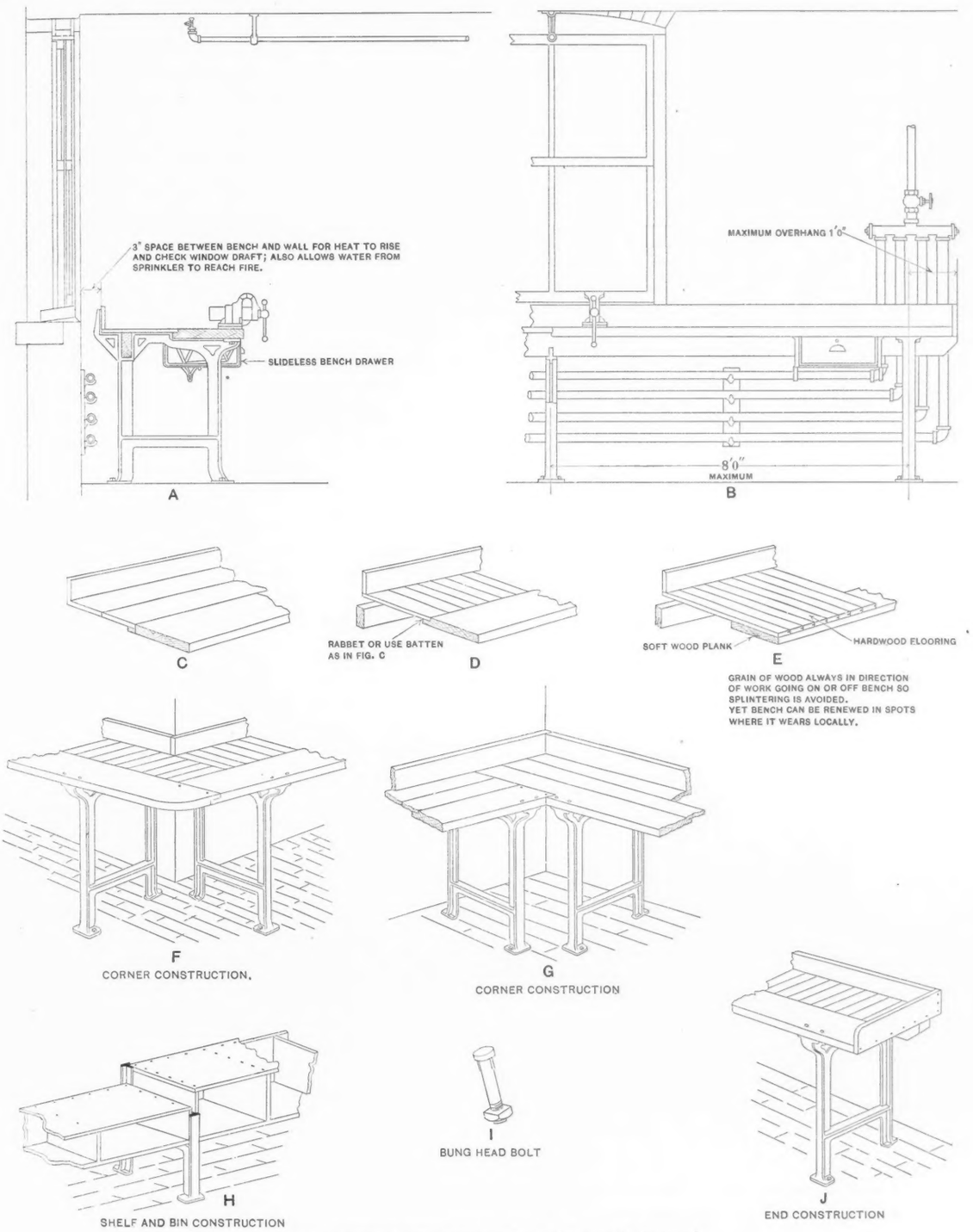

3" SPACE BETWEEN BENCH AND WALL FOR HEAT TO RISE AND CHECK WINDOW DRAFT; ALSO ALLOWS WATER FROM SPRINKLER TO REACH FIRE.
SLIDELESS BENCH DRAWER
A
MAXIMUM OVERHANG 1'0"
8'0" MAXIMUM
B
C
RABBET OR USE BATTEN AS IN FIG. C
D
SOFT WOOD PLANK
HARDWOOD FLOORING
E
GRAIN OF WOOD ALWAYS IN DIRECTION OF WORK GOING ON OR OFF BENCH SO SPLINTERING IS AVOIDED. YET BENCH CAN BE RENEWED IN SPOTS WHERE IT WEARS LOCALLY.
F
CORNER CONSTRUCTION.
G
CORNER CONSTRUCTION
I
BUNG HEAD BOLT
H
SHELF AND BIN CONSTRUCTION
J
END CONSTRUCTION

Fig. 10. Details of Work Benches with which Plant is Equipped.

Heating System.

The factory is heated by exhaust steam on the overhead main system. The object of this, as is well known, is to main-

tain a uniform direction of flow of the steam and condensation. From the exhaust pipe in the attic a back pressure valve compels travel of steam through the main along the roof. This main is enlarged for one length of pipe, preceding the introduction of an oil eliminator, to provide one square inch area of pipe to each 1½ pounds of steam passed per second. The waste from this eliminator is trapped into the sewer, and beyond this point all returns from the heating system are condensed and used in the boilers, and so far there has been no appearance of any oil having come over. It will be noted

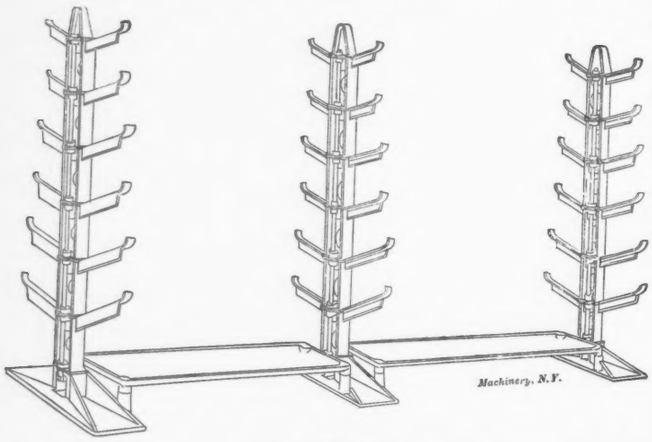


Fig. 11 Stock Rack.

that the large main along the roof is just sufficient to take care of the added exposure on that floor, and as a matter of fact it will keep the sprinkler pipes from freezing, even though the side wall coils are shut off. These side wall coils all have a corner in them or are mitered to provide take-up in case of unequal expansion. They are proportioned on a basis of 1 square foot of heating surface to each 4 square feet of glass in the room; another square foot of heating surface for each 20 square feet of wall, and another square foot of heating surface for each 600 cubic feet of contents. One and one-half-inch pipes are used throughout the coils.

Fig. 12. Foreman's Desk, built high, so he can Overlook his Room when Sitting at his Desk.

In the basement, owing to the difficulty in getting returns back, the coils were placed overhead. The outside stairway is heated by a single pipe from top to bottom, and the closets by a hairpin loop, running from top to bottom. The lowest returns are helped into the tank of pump and receiver by a suction tee.

The office is heated by direct-indirect radiators. A screened duct through the brick wall delivers fresh air under the base of radiator, and this may be mixed with the room air or shut off entirely, as desired. A greater amount of heating surface, of course, is provided here than would be in the shop.

Fire Protection.

The city is supplied with water by the gravity system, and there is 75 pounds pressure available at the company's works for fire protection. In addition to this the underwriters requested a 10,000-gallon tank to be placed on the roof, with the bottom 10 feet above the highest sprinkler. To keep the tank from freezing, it is located directly over a steam-heated room in the building, which has an opening through the ceiling, allowing the heat to rise against the bottom of the tank. It was a question whether this system of heating would be sufficient in all weather, but in the severe winter just passed the result justified the arrangement.

There are tinned fire doors on all openings, these doors being supplied with automatic closers and fusible links, melting at 160 degrees Fahrenheit. The sprinkler heads are set at the same temperature. The hydrant and hose are made to interchange with the city fire department's standard threads. A dozen fire pails are provided for each 5,000 feet of floor space, and chemical extinguishers still further augment the protection. Suitable receptacles for the waste are placed on each floor, and benches kept 3 inches away from the wall, as will be noted in the details of bench construction, Fig. 10.

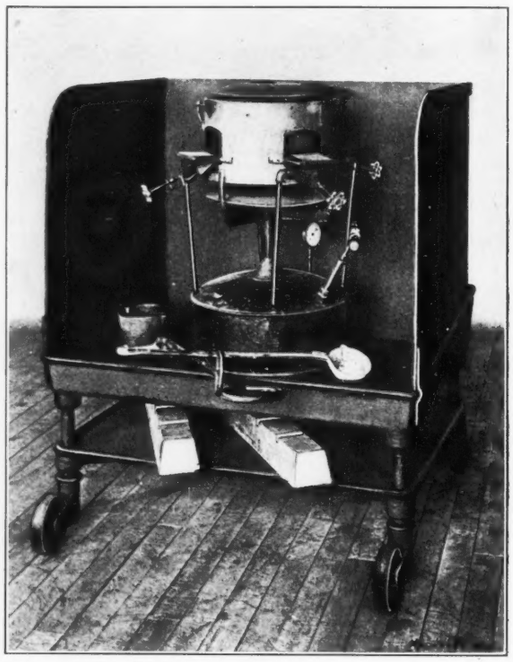


Fig. 13. Portable Babbitt Melter, with Protecting Stand.

Lighting.

The shop is lighted by incandescent lights, the current for which is supplied by a dynamo in engine testing department. This dynamo may be run with basement engines or any engine which may then be on the testing plate, for its final run and regulation adjustment. When the shop is not running, current may be taken from the city service for convenience of the office or night watchman.

Products.

The New Britain Machine Company is engaged in the manufacture of patented specialties, which include a chain saw mortiser—a woodworking tool; the Case steam engine, already mentioned, a small high-speed machine built in sizes from 2 to 25 horse power, and it was here that "Shop Furniture" originated. In fact, the term shop furniture was coined to describe the class of goods made here, which includes racks to hold stock in bars, various styles of lathe pans, tool racks and bench legs, every effort having been made to standardize many of the needful things in a machine shop, which have been made hitherto by each shop for itself.

One article of "furniture" recently placed on the market is a stock rack, shown in Fig. 11, for holding merchant bars of stock, or other material. The three uprights, spaced six feet apart, with six graduated double hooks in each upright, are of

proper proportions to equally support bars of merchant steel 18 feet long and will hold upward of 7 tons without danger of overloading. The unit idea is carried out so the rack can be expanded or contracted to meet changing requirements. The hooks and tension bolts are of steel and distance pieces of cast iron. This selection of materials in combination gives the greatest strength with least weight. The pans at the bottom are useful for holding short pieces and odds and ends.

When the shop was completed it was equipped throughout with work benches designed by the company and which proved so satisfactory and seemed to embody so many good features that the legs and other metallic parts have since been put on the market, as another addition to their shop furniture line. The details of the benches are so clearly outlined in the large engraving that description is unnecessary. We believe, however, the sketches showing the bench construction will offer to many of our readers several ideas that will be appreciated.

Commencing four years ago, the practice of the company has been to discard about twenty machine tools each year, replacing them with more modern types, with the result that there is hardly an old-fashioned tool in the shop, and the equipment represents the most advanced ideas of modern builders.

Every lathe in the shop is provided with a portable lathe pan of the company's make, and lathe rack to slide on ways and carry the small tools, waste, oil can and light work. These lathe racks are easily removed from the ways, if desired to

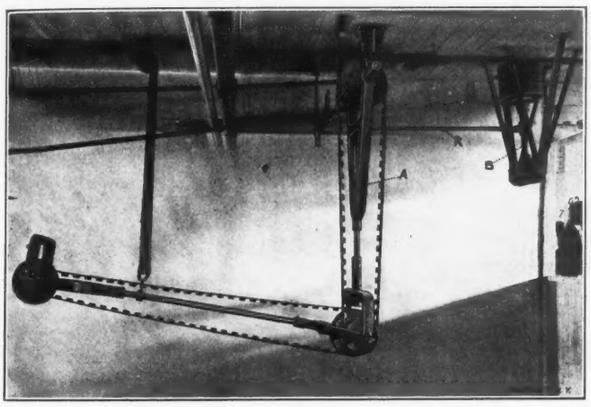


Fig. 14. Counterbalance Device for Swing-frame Grinder.

work up to full length of bed. The proximity of a portable tool rack and workman's chest or kit is believed to still further enhance his productivity.

A Portable Babbitt Melter.

In connection with the assembling work on the chain mortisers, there is considerable babbitting to be done in place. This is true of most woodworking machinery, and is a practice which persists, owing to the facility with which the ordinary mill man can make repairs of babbitted bearings. To handle this work expeditiously, a portable babbitt heater is used, which can be moved down the line of machines being assembled, as shown in Fig. 13. This consists of a gasoline four-burner melting pot placed in a New Britain Machine Company's pan rack hooded about on three sides and cut down low to bring the melting pot down to a convenient height for ladling. The capacity of the pan is more than the tank of heater.

The lower shelf makes a convenient place for babbitt, while ball bearing swivel casters of generous size insure prompt facing about and easy travel. By having the melter within a foot or two of where the babbitt is actually poured, there is no necessity or excuse for overheating same. This is the only fire in the main building. It is used, of course, only when babbitting is to be done, with a workman constantly beside it. When the job is finished the fire is put out. Should there be any leakage or ignition of gasoline, through accident, the instructions are to push the outfit out into the yard.

Swing-frame Grinder.

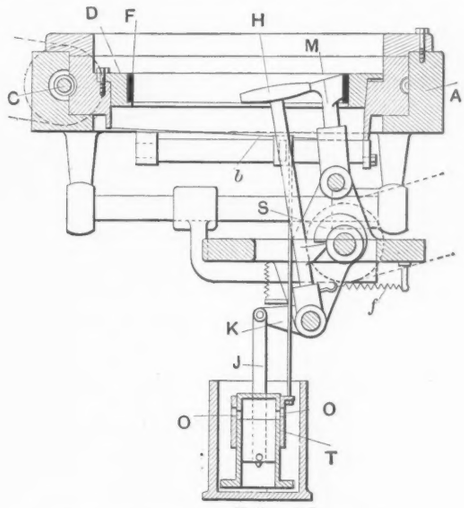
The limitations which surround the use of a swing frame grinder are splendidly eliminated by the mechanism shown in Fig. 14. Ordinarily with low head room, the labor necessary to move the wheel over a long surface is very great, since with even a small angle of motion the labor at both extremes amounts largely to a lift. To overcome this the counterpoise weights shown were devised. These weights lend themselves to the work of balancing the wheel mechanism immediately it is moved off center, and thus a long swing—aggregating some five feet—may be accomplished with ease. This casting cleaning method seems better suited than air chippers on the large flat surfaces of the class of castings handled here. In the illustration, *A* is the swing frame, connected with the counterpoise lever *B* by the rod *R*.

* * *

AUTOMATIC PISTON RING HAMMER.

The accompanying illustration is of an ingenious tool for expanding piston rings by pening on the inside of the ring. Piston rings are frequently expanded by hammering with a hand hammer, but it is difficult to so locate and graduate the blows as to expand the ring uniformly and cause it to bear against the walls of the cylinder with uniform pressure around the whole circumference.

This is automatically accomplished, however, by the hammering machine, which delivers its blows in such a manner that the greatest stress in the piston ring is set up at a point



Machinery, N.Y.

Automatic Hammer for Pening Piston Rings.

diametrically opposite the joint. The hardest blow of the hammer is delivered at this point and the blows then decrease symmetrically in each direction until the joint is reached, where they are at a minimum, with the result that a uniform spring is set up in the ring. This insures that the ring will wear evenly and prevents the cylinder from wearing ovally, a difficulty met with when piston rings are used whose spring is not uniform.

The machine consists of a table *A*, with a revolving ring *D*, on the top, rotated by a screw *C*, and inside which the piston ring *F* is placed, and secured by three clamping screws. Several sizes of revolving ring are used to suit pistons of different diameters. Inside the ring is a small wedge-shaped swage *M*, kept out of contact by a spring. This swage is struck on the head by a hammer *H*, actuated as shown by a cam *S*, and spiral spring *f*. The hammer spindle is fitted with a bell crank *K*, governed by an oil dash pot, *J*, with a by-pass, as shown. The discharge of oil is regulated by a ring *T* round the cylinder, opening more or less perforations *O O*, through which the oil can escape. This ring is moved gradually up and down by the incline *b*, on the under side of the revolving ring, and so the force of the blow on the head of the swage is regulated. The machine is made by Act. Ges. Davy Robertson's Maschinenfabrik Filiale, Hamburg.

* * *

The Henry R. Worthington Hydraulic Works now nearing completion at Harrison, N. J. (suburb of Newark), contains 18 acres of floor space and will accommodate 5,000 employes.

EARLY STEAM ENGINES.—3.

CENTRE SQUARE PUMPING ENGINES AT PHILADELPHIA

In the article by Mr. Bell, in the June number, upon the beginnings of the steam engine in England, and in the extract from the writings of James Watt, under the heading of "Early Steam Engines," in the July number, the work of James Watt—the father of the steam engine—was treated somewhat in detail. It now seems appropriate to shift to America and see what was being done to introduce the steam engine into this country.

Some time ago reference was made in MACHINERY to the ancient pumping engine at Belleville, N. J., which was built by Hornblower in England and brought over here to drain the Belleville copper mines of Col. John Schuyler. This was in 1753 and it apparently caused no awakening to the possibilities of steam, as did what was perhaps the most important early steam engine installation in this country—namely, that of the Centre Square Water Works, at Philadelphia, in 1801. Drawings showing the probable design of the engines and boilers of these water works were made by Frederick Graff, one of the early engineers of the Philadelphia Water Works

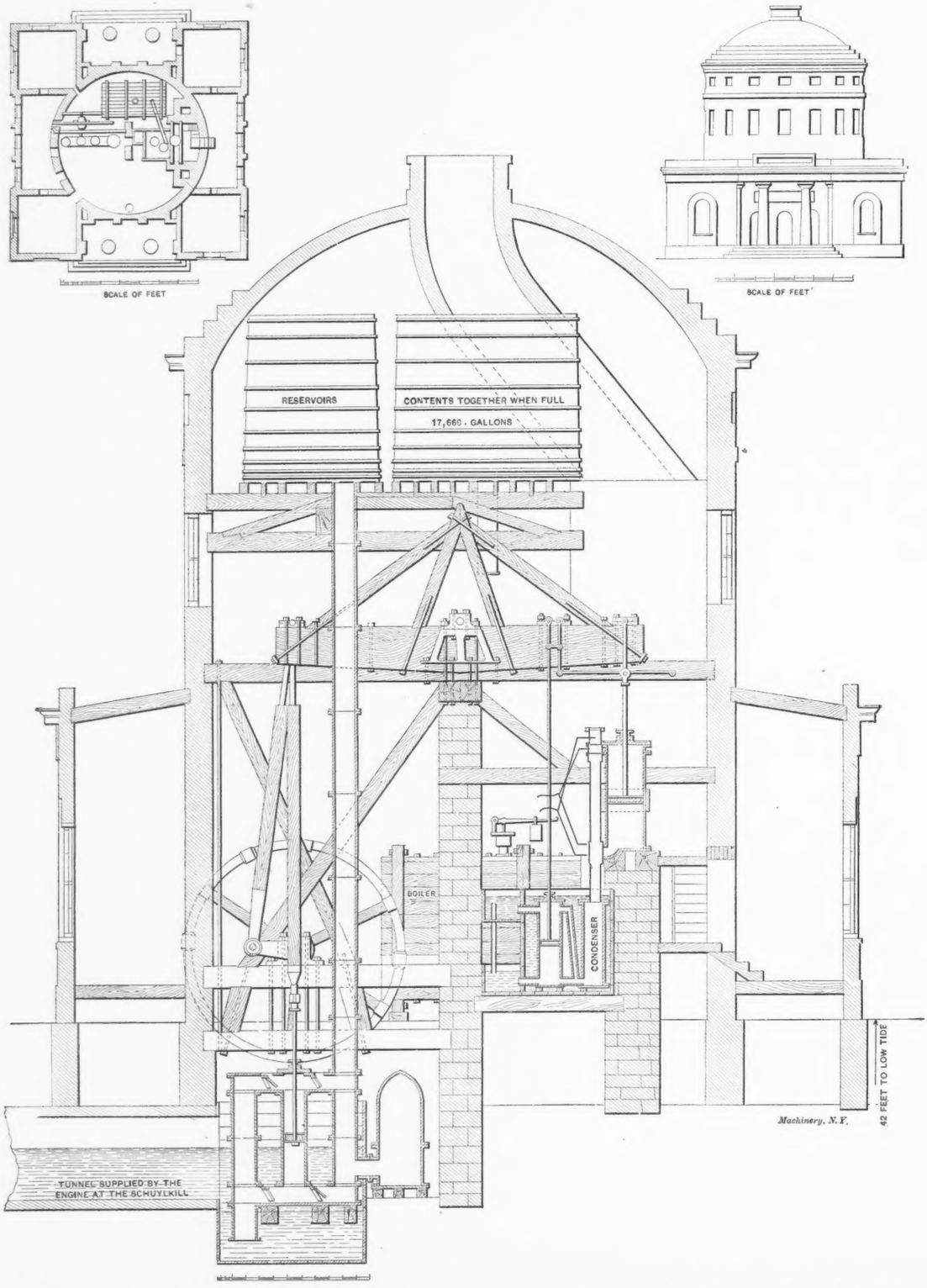


Fig. 1. Centre Square Water Works, Philadelphia; Section of Building showing the old Pumping Engine originally Installed there.

system, from data in his possession, and are now at the Franklin Institute, Philadelphia. They were reproduced in *The Engineering News*, May 14, 1903, from which publication our engravings have been made. The particulars with regard to these works, which follow, are taken from the annual report of the Chief Engineer of the Water Department of Philadelphia for 1875. This is now a valuable and rare pamphlet, containing as it does much historical matter.

At the end of the eighteenth century Philadelphia was confronted with a fever epidemic resulting from the drainage from cesspools reaching the strata of the earth where the water lay that supplied the numerous wells from which the city secured its water. The covering of the ground in the heart of Philadelphia with buildings and pavement had prevented rain from soaking in to replenish the wells and the digging of the cesspools through the clay substrata to the porous ground beneath had allowed the drainage to mingle with the water, with the result of the fever epidemic mentioned. Benjamin Franklin first aroused public sentiment to the importance of a pure supply of water by presenting a plan for bringing water into town by means of pipes. Among other schemes was a proposition for a reservoir in Centre Square having an elevation of 40 feet to "throw the water up into fountains, and the water of the Schuylkill to be conducted to and raised into said reservoir by steam, at an estimated cost of $75,000." This latter plan was adopted in 1799 by the City Councils, and the Centre Square Water Works were located where the city buildings now stand.

To raise money was difficult, and the committee jointly and individually had their notes discounted to carry on the work, the subscribers to the water loan receiving a three years' supply free from January, 1801.

Steam, the motive power, was then a novelty, there being but three steam engines of any considerable size in the United States: the imported Hornblower engine mentioned above, at Belleville, N. J.; another at a sawmill, in New York; and the third in Philadelphia, used for grinding plaster, by Oliver Evans; it was therefore difficult to find skillful and experienced persons to construct the engines. A contract was made with Nicholas J. Roosevelt, of Soho Works, on the river Passaic, in New Jersey, for the construction and erection of two steam engines of capacity to raise three million gallons per day 50 feet high, to maintain and keep them in repair five years, for the sum of $30,000. These were the largest and first pumping engines in the United States, and with the tools and experience of the time it was a great undertaking.

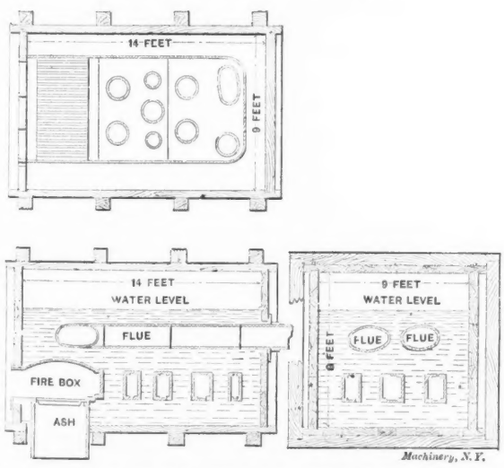


Fig. 2. Wooden Steam Boiler used at the Centre Square Water Works from 1801 to 1815.

The City having determined to obtain its supply of water, the following is a general description of the arrangements and connections:

A basin was formed on the Schuylkill River, at the foot and on the north side of Chestnut Street, extending from low water-mark 200 feet eastwardly, and 84 feet wide, provided with a set of tide-lock gates. The bed of this basin was three feet below low water-mark; thence the water passed through a sluice to a second basin or canal 40 feet wide and 160 feet long. The sides of both basins were inclined, paved, and coped with marble; at the head of the canal was a sluice-gate set in marble, which admitted the water into a subterranean tunnel of oval form, six feet in its greatest diameter, and 300 feet long, cut through solid rock nearly the whole distance, its bed level with low water, and emptying into a shaft or well 10 feet diameter, and 39 feet deep, 22 feet of which was cut out of solid rock, and in which was placed the pump, the bottom chamber being on a level with low water. This was called the Lower Engine House, and was located at the northwest corner of Chestnut and Schuylkill Front (Twenty-second) Streets, where the water was raised into a brick tunnel six feet in diameter, and 3,144 feet in length, leading the water under ground down Chestnut to Broad; thence to the Centre Square Engine House, where it was again pumped to a height of 36 feet from the surface, or 50 feet from bed of brick tunnel, into two tanks of 17,094 ale, or 20,868 wine gallons capacity; from thence it descended into an iron chest 4 by 8 feet, outside the building, to which the wooden mains were connected that supplied the city. Two 6-inch down Market, one 4½-inch down Arch, and one 4½-inch down Chestnut to Front Street; from these the water was distributed through 4-inch and 3-inch logs.

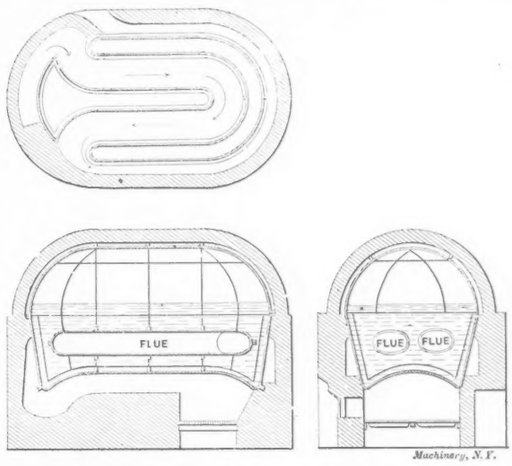


Fig. 3. Cast Iron Boiler used at Schuylkill Engine House, Philadelphia.

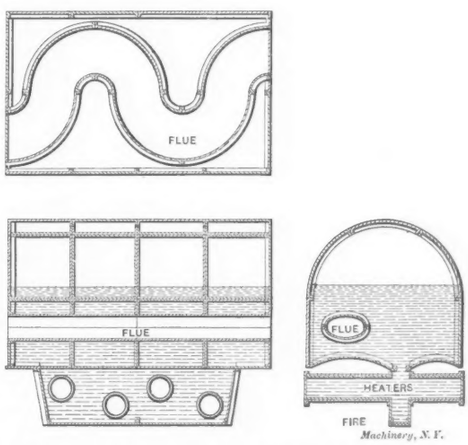


Fig. 4. Cast Iron Boiler, Centre Square Works, 1804.

The Schuylkill engine house was 66 by 54 feet, built in the most substantial manner to contain two engines and pumps, though only one was ever put in.

The Centre Square engine house was an exceedingly handsome building of marble, the lower story containing the offices, committee and engineers' rooms, built in the form of a square of 60 feet, 25 feet high, with two porticos, and surrounded a circular building 40 feet diameter and 60 feet high, covered by a dome, through the center of which the stack was carried.

The engines in both buildings were very defective in every

respect, the lever beams, flywheels, shafts and arms, cold water pumps and cisterns, *being all made of wood.* The main steam cylinder of the Centre Square engine was cast in two pieces, united by copper, the joints being secured externally by a cast-iron band 18 inches wide; and although it was but 6 feet 6 inches long, and 36 inches in diameter, nearly four months were occupied in boring it out fit for use. This is an incredible statement, but it seems well confirmed.

The boilers to both engines were wooden boxes 9 feet high, 9 feet wide, and 15 feet long, made of five-inch white pine plank, securely bolted through and braced on the outside. The fire-box inside the boiler was of wrought-iron, with vertical flues of cast-iron; subsequently, a cast-iron boiler was substituted.

At that time wrought-iron could not be obtained in sheets larger than 15 inches by three feet when it was squared; which had to be done by the purchaser. All the castings were patched by gun boring, cement, and hard-solder.

The pumps were double-acting force, and had to be lined with sheet copper before they could be made air-tight. At first they were made without air-chambers, which were added to the Centre Square pump in 1810, but were useless until lined with sheet lead.

The first cast-iron boiler built was used at the Schuylkill Works, and was so successful that a similar one was placed at Centre Square.

In 1807 the forging and finishing of a 4-inch piston rod 10 feet long was thus noticed in the annual report of the Watering Committee—"The workmanship of this piece of iron could not, in the opinion of our Committee, have been better done in any country." This rod was generally looked upon as a remarkable piece of work.

In 1809, a cast-iron flywheel shaft replaced a wooden one.

Fears were entertained that the price of wood, $4.50 per cord, and of bituminous coal, 33 cents per bushel, would be enhanced by the amount used by these engines, and that there would be difficulty experienced in procuring a sufficient supply.

These considerations, with the trouble of keeping the engines in repair, and the constant difficulties with the boilers, as well as the small storage in the tanks at Centre Square Engine House, rendered the supply intermittent and uncertain, which led Councils to have another examination made, which finally led to the establishment of the Fairmount Works.

Up to 1815, the city had received no direct pecuniary benefit from the water works, in fact not enough was realized from water rents in any one year to pay for the fuel and the working of the engines.

The cost of the Schuylkill and Centre Square Works, with yearly expenses added, from March, 1799, to September 1, 1815, when steam was started at Fairmount, was $657,398.91, the whole gross receipts amounting to but $105,351.18, leaving a deficiency of $552,047.73, without interest.

Yet it cannot be said this sum has been lost to the City, as many indirect advantages have arisen from it. Character and impetus was given to the City, much was done to improve its sanitary condition, an important feature which added to its many attractions as a place of residence. Nor was the early experience thus acquired by her mechanics a small matter, for perhaps to their pumping engines and the practical knowledge derived from them, may be attributed much of the preeminence which Philadelphia early enjoyed.

The original works at Fairmount, driven by steam power, were commenced August 1, 1812, to supplant those at Broad and Chestnut, and were put in operation September 7, 1815.

In a house at the foot of Fairmount Hill, was erected a Bolton and Watt engine of 44-inch cylinder, and 6 feet stroke, working a double-acting pump of 20-inch diameter and 6-feet stroke, raising the water through a 16-inch main, 239 feet long, into a reservoir 102 feet above low water in the Schuylkill. The boiler had a cast-iron case with vertical flues or heaters of wrought-iron, carrying 2½ to 4 pounds pressure of steam.

Although at this time considerable improvement had been made in building machinery, yet not a single furnace could be found large enough to cast the steam cylinder entire, the nozzle pipes being cast separately and bolted on, though their weight was but 1¾ tons.

Before starting the works a contract was made with Oliver Evans for one of his high pressure engines, then coming into notice. It was accordingly put up, dimensions as follows: steam cylinder 20 inches diameter and 5 feet stroke, with a pump 21 inches diameter and 4 feet stroke. This engine was supplied by 4 cylinder boilers 30 inches diameter and 24 feet long, upon which a pressure of 220 pounds was sometimes carried. The engine upon trial, raised 3,072,656 ale gallons in 24 hours, running 24¾ revolutions per minute, and carrying 194 pounds of steam with a consumption of 13 cords of wood. It was put to work December 15, 1817; the cost at that time to raise 2,300,000 ale gallons per 24 hours being $84.50.

The population rapidly increasing, the difficulty and expense of keeping up a sufficient supply with the machinery then in use kept Councils constantly on the alert for a cheaper and more copious supply of water. The expense will be seen by the estimate of the working of the Oliver Evans engines, as made by the superintendent of the works for one year, for an average of 2,300,000 ale gallons per day:

Six men at $9.75 per day	$3,558.75
Tallow, and chandlery, etc.	1,250.00
3,650 cords wood, cording, hauling, etc.	24,550.00
Wear and tear of machinery	1,500.00
	$30,858.75

or $36.60 per million gallons pumped into the reservoir.

* * *

USE OF THE STROBOSCOPE.

It is a peculiarity of vision that impressions on the retina do not fade instantly but persist for a fraction of a second after a change has taken place in the aspect of the object viewed. This persistence of vision is what enables a fairly good view of a fair ground or baseball field alongside of a railroad track, to be seen from the window of a rapidly-moving train, when, if the train were standing still, all that could be seen would be a high fence with narrow cracks between the vertical boards. When the car carries one by the fence rapidly the eye receives a series of views of the field through the cracks, which blend together and give the panorama effect. This peculiarity is taken advantage of in investigating the action of certain vibrating or revolving mechanisms like engine flywheel governors, etc. If a rapidly-running flywheel governor is seen for a fraction of a second at one spot at every rotation, it appears to the eye to stand in space and under that condition the in-and-out movements caused by changing load, may be readily seen. One method of obtaining this effect is to mount a radially-slotted disk on the flywheel shaft so that the slot covers the portion of the governor to be watched. In front of this disk is another slotted disk which stands stationary. Now if a strong light illuminates the object a flash of reflected light will reach the eye at every revolution. The same stroboscopic effect was obtained in another way in the elaborate investigations of the Pelton water wheel which were carried on some months ago. To perfect the shape of these buckets so that they should have the maximum of efficiency and durability it seemed necessary to observe the action of the jet as it impinged on the buckets, but to get a perfect visual impression the buckets should stand still, which, of course, was impossible in running tests. An arc lamp was arranged with a shutter, which was worked in synchronism with the revolving water wheel. At every revolution a flash of light was directed upon the jet and buckets, giving them the impression of standing still while the water entered the buckets and flowed out at the sides. With the same apparatus instantaneous photographs of the jet and buckets were taken.

* * *

A comparatively new time- and labor-saving product is a self-fluxing solder. A bar of the solder consists of a tube, filled with the flux, which is pinched together at short intervals so that the flux is divided into small portions contained in cells or pockets. As the bar is used the contents of the cells are successively released upon the work, thus relieving the user from the necessity of carrying about a pot of acid and applying it to the work with a brush.

NOTES ON DIE MAKING.

FRANK E. SHAILOR.

Through the courtesy of Mr. Herbert M. Smith, Works Engineer of the Stanley Instrument Co., the die, Fig. 1, is shown. This die was designed by the above-named gentleman and contains several novel features that will be found valuable to many engaged in die making. As the sub-press die, frames, and power sub-presses are of standard dimensions, it too frequently occurs that a die is required of size that

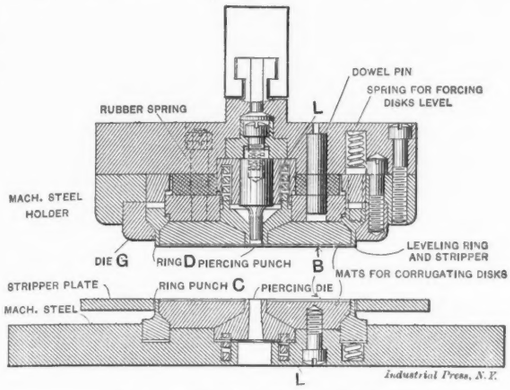


Fig. 1. Vertical Section through Die.

necessitates specially made frames, and invariably a specially made press. The sketch, Fig. 1, shows a practical way to construct a die that not only is a compact self-contained die, but can be fitted to any style of press (of sufficient strength) having any length of stroke.

This particular die was designed to produce the disk shown at *A*, Fig. 2, and previous to its introduction the disks were blanked out with a plain open die and then leveled by hand. The disks are of aluminum, 99 per cent. pure, therefore, very

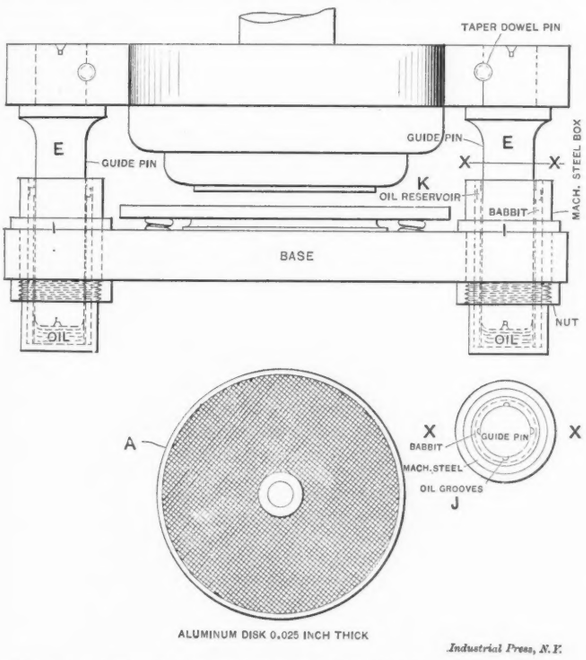


Fig. 2. Side Elevation of Die and Plan of Guide; also Sample of Work.

soft, and as it is very essential that they should run as true as possible, great difficulty was experienced in leveling them. The corrugating mats *B B* were designed to level the disk and also to set, or stiffen the metal, and they proved a success, for when the disks leave the die they are as nearly level and true as is possible to make, and so stiff that they can be handled quite roughly without injury. The disk was not corrugated its entire surface owing to the fact that the mat would be obliged to act as the blanking punch, and if the corrugations extended clear to the edge of mat, same could not be sharpened when dull. Therefore the rings *C D* were introduced. The ring *C* acts as the blanking punch, and ring *D* acts as a leveling ring. The die is guided by means of two guide or pilot pins, *E E*, Fig. 2, and as the gate of press descends the rings *C D* are the first to act on stock to be punched, gripping it from above and below and holding the stock securely. Then as the press continues downward the rings settle back, still holding the stock, and the mats *B B* grip the blank.

The rubber spring (which is one of the features) exerts an increasing pressure on the metal, pressing it into the corrugations on the mats. The press is so adjusted that the ring *C*, which is the blanking punch, comes exactly flush with the die *G*, but does not enter. On the upward stroke of press the springs and rubber plate force the moving parts back to their original position, and force the disk out of the die, and the surplus stock off the ring *C*. The rubber plate can be advantageously used in a small place where a very strong spring

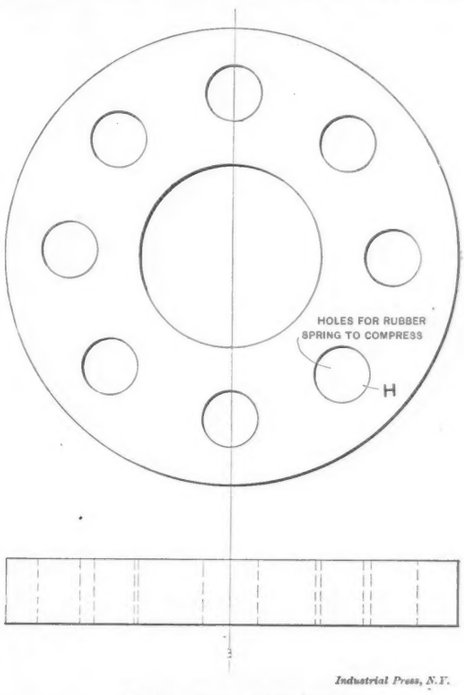


Fig. 3. Spring Rubber Plate.

is required. The tension or spring effect is obtained by cutting holes *H* in the plate, Fig. 3. The more holes there are in plate the weaker the tension, as the holes permit the surrounding rubber to squeeze into them. On the other hand if no holes were cut in rubber plate and same fitted the recess bored for rubber plate, there would be no more spring effect than if a metal plate was used. Rubber does not compress but merely changes shape.

Another novel feature is that the guide pins are automatically lubricated at each stroke of the press. The pins run in the babbitt boxes *I I*, Fig. 2, which have four grooves, *J*, cut the entire length of the babbitt, and an oil chamber or reservoir *K* recessed near the top. A quantity of oil is placed in the bottom of the box and as the pins descend they force the oil up through the grooves *J* into the reservoir, and as the pins ascend they form a partial vacuum at the bottom of the box, which sucks the oil back to the bottom.

Space will not allow describing the methods employed when making each part of the die, but suffice it to say that with the exception of the mats, screws and holder, the parts were hardened and *accurately* ground, making a smoothly running die. It might be well to mention the method employed in making the square springs *L*.

FRANK E. SHAILOR was born in New Haven, Conn., December 14, 1875. His education was acquired in the high school and the technical part by home study. His shop experience began with the Winchester Repeating Arms Co., New Haven, Conn., where he learned his trade. He has worked for the New Haven Bicycle Co., Stanley Instrument Co., Greist Mfg. Co., Hoggson & Pettis Co., and others with whom he has held the positions of foreman, etc. With one concern he was in charge of the manufacture of cyclometers for two years. His specialties are fine tool work, punches and dies, and accurate jig-making.

The reader knows only too well what a mean job it is to wind a heavy coil spring and have same a given diameter inside and outside, when finished. A large spring is generally made by heating wire red hot, and winding as many coils as possible before cooling, then reheating and winding more coils. The springs *L L* were made by gripping a piece of round tool steel in the lathe chuck and turning to the given outside diameter. The lathe was then geared to cut a coarse pitch thread and with a square thread tool, the thread was cut sufficiently deep. The inside of the spring-to-be was then bored out to proper diameter, leaving a spring the coils of which are evenly spaced, thereby causing each coil to perform

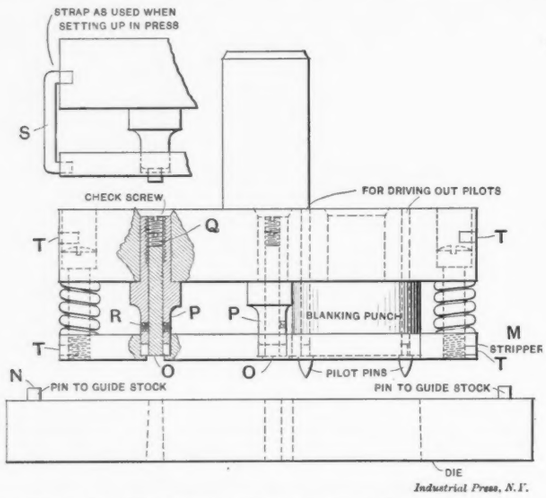


Fig. 4. Die With Stripper Attached to Punch to Flatten Stock.

equally its share of the work. With a wound spring the coils are very seldom equally spaced, and when under pressure there is a greater strain on the coils furthest apart, causing the spring to either "set" or break at that point.

After all parts of the die were completed the die was assembled, leaving out the springs. The upper and lower part were then brought together until the punches entered dies, care being exercised that upper and lower part of the die were perfectly parallel with each other. The boxes *I I* were then babbitted, first treating the guide pins with a light coating of flake graphite and oil to prevent babbitt sticking to the pins. The writer considers that a large die of above description is far superior to the ordinary sub-press die, inasmuch as it is more compact, and also does away entirely with the cumbersome cast iron frame.

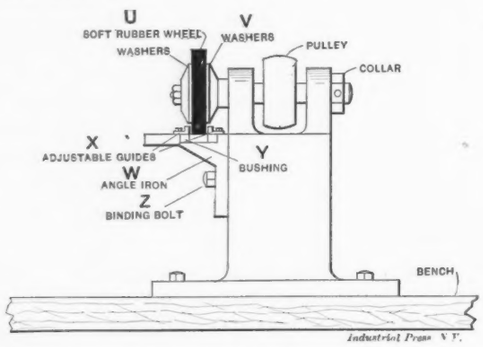


Fig. 5. Machine for Separating Blanks from Stock Strips

Fig. 4 shows a die that is designed to take the place of the plain, open double die. The ordinary double die is made with the stripper fastened to the die and stripper planed out to allow stock to slide through. The reader knows the unsatisfactory results obtained when using a die of this style. The greatest fault is that no two blanks are exactly alike, owing to the fact that the stock is wrinkled and does not lie level on the die. As the punches descend they pierce the stock without leveling same, and as the blanks are afterward leveled it is found that the pierced holes being unevenly spaced will not allow the blanks to interchange. By making the die, as shown in Fig. 4, with the stripper plate *M* fastened to punch-holder and a stiff coil spring at each corner, and so adjusted that the punches do not come quite flush with the face of the stripper, the above-mentioned trouble is nearly eliminated. On the downward stroke of press the stripper *M* presses the stock firmly against the die, holding it level while the punches perform their work. The stock is guided by means of a small pin *N* at each end of die. The stripper should not fit the punches; for if the operator should make a miscut, or should a piece of scrap punching get under the stripper, it would cause same to tilt and bring disaster to the small punches.

Another valuable feature in this die is the manner in which the piercing punches *O O* are constructed. Ordinarily piercing punches are made solid, and if one breaks it necessitates making a whole new punch or grinding the other punches down to same length, greatly shortening the life of the die. The punches shown at *O O* are designed to overcome this trouble. A holder *P* is made and left soft, into which the punch *O* (or rod) is inserted, being backed up by the screw *Q* and prevented from pulling out by means of the screws *R*. Then should one of the punches "flake" off, that same punch can be ground and then forced out by means of the screw *Q* until it is the same height as the others. This style of piercing punch greatly increases the life of a die. This die can be made either with or without the guide pins *E E*, in Fig. 1. If made without the guide pins it is necessary to use the straps *S* to allow aligning punches with die when "setting up" in press. The stripper is forced back and the straps inserted in the holes *T T*. After the die is "set up" and securely fastened the straps are removed.

All presses in which double dies are used should be provided with a separator, which is a piece of sheet metal fastened underneath the press to separate the scrap punchings from the blanks. The writer has frequently noticed that in factories where no separator is used the cost of sorting the blanks from the scrap is in excess of the cost of blanking. The reader knows that a sub-press die leaves the blanks in the strip of stock. If the stock is over .02 inch thick considerable trouble is experienced in removing the blanks. Fig. 5 shows a means, designed by the writer, whereby the blanks are forced from the strip without marring them. *U* represents a soft rubber wheel, which is supported on the sides nearly to the edge by the washers *V*. The angle iron *W* is provided with adjustable guides *X* and is recessed at *Y* to receive bushings having different sized holes. A bushing is inserted in the angle iron having a hole somewhat larger than the blanks to be forced out. The guides *X* are then adjusted to allow the strip to slide freely. The angle iron is then raised by loosening the bolt *Z* until sufficient pressure is brought on the rubber wheel. The wheel being power driven, all that is necessary is to place the end of a strip under the rubber wheel and it will roll the strip along, at same time forcing out the blanks.

* * *

TEST OF TURBINE PUMPS.

The development of the steam turbine has logically been followed by an extension of the powers of the centrifugal pump, until now the indications are that the combined high-speed steam turbine and centrifugal or turbine pump will eventually supersede the ordinary reciprocating steam pump for many purposes. The centrifugal pump, in its simple form, is, of course, a very old machine, but it has been made effective for working against high heads only since the development of the modern steam turbine. In view of this advance and the meagerness of the published data on the subject the report of the recent tests made on three De Laval turbine pumps by Professors James E. Denton and William Kent at the works of the De Laval Steam Turbine Co., Trenton, N. J., is of considerable interest. Two of the pumps were driven by steam turbines and the third was operated by an electric motor. One of the turbine-driven pumps was single-stage and the other was a double-stage machine; the motor-driven pump was single-stage. The objects of the tests were: 1. To determine the efficiency of the pumps, expressed as a ratio of the water horse power to the brake horse power of the steam turbines driving them. To determine their economy in millions of foot-pounds per thousand pounds of commer-

cially dry steam. 3. To provide means for determining the economy of the electrically-operated pump.

No. 1 pump was a single-stage centrifugal machine designed to lift 1,700 gallons of water per minute against a head of 100 feet when running at 1,545 turns per minute. It had 8-inch suction and discharge pipes and the runner was 13.75 inches diameter. It was driven by a 55-horse power De Laval steam turbine with a speed reduction of 10 to 1. It was found that the water horse power was at a maximum of 44½ horse power when delivering 1,760 and 1,860 gallons per minute at lifts of 100 and 95 feet, respectively. The efficiency of the pump to the brake horse power of the steam turbine ranged from 0.743 to 0.756 for delivery between 1,398 and 1,860 gallons per minute. The duty of the pump when running condensing ranged from 60,000,000 to 61,860,000 foot-pounds per 1,000 pounds of steam within the same limits; the duty decreased to 54,470,000 foot-pounds per thousand pounds of steam when the delivery fell to 1,001 gallons per minute against a head of 126 feet. The steam consumption per brake horse power when running condensing ranged between 24.06 and 24.53 pounds for deliveries between 1,398 and 1,860 gallons per minute.

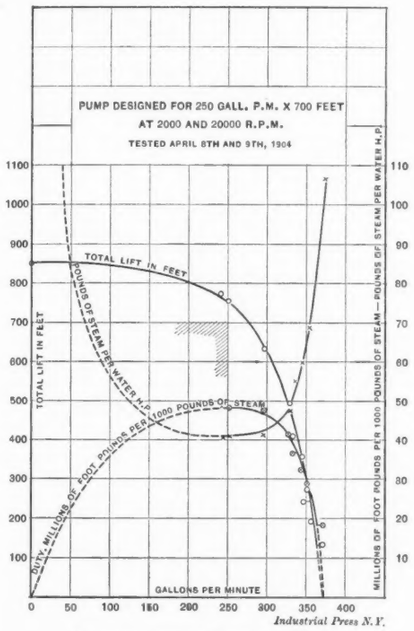

PUMP DESIGNED FOR 250 GALL. P.M. X 700 FEET
AT 2000 AND 20000 R.P.M.
TESTED APRIL 8TH AND 9TH, 1904
TOTAL LIFT IN FEET
POUNDS OF STEAM PER WATER H.P.
DUTY—MILLIONS OF FOOT POUNDS PER 1000 POUNDS OF STEAM
GALLONS PER MINUTE
TOTAL LIFT IN FEET
MILLIONS OF FOOT POUNDS PER 1000 POUNDS OF STEAM—POUNDS OF STEAM PER WATER H.P.
Industrial Press N.Y.

Diagram showing Results of Tests.

No. 2 pump was driven by an electric motor of 20 horse power, and was designed to lift 1,200 gallons per minute against a head of 45 feet when running at a speed of 2,000 turns per minute. The suction and discharge pipes of this pump were also 8 inches diameter. The tests showed a delivery of 790 to 1,403 gallons per minute, working under heads of 59 and 30 feet respectively. The efficiency ranged from 0.714 for the maximum delivery of 1,403 gallons, to 0.750 for a delivery of 1,133 gallons. The efficiency fell to 0.683 for a delivery of 790 gallons per minute against the maximum head of 59 feet. The maximum electrical horse power or a brake horse power of 17.72 was attained at a delivery of 986 gallons per minute against a head of 53 feet. These heads also include suction lift.

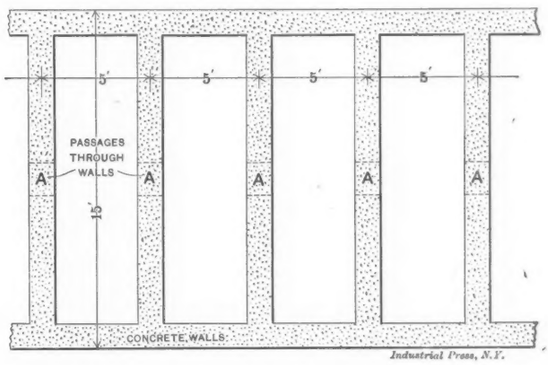
The third pump tested was a two-stage machine having runners 9 feet and 2.84 inches diameter respectively. This pump was designed to lift 250 gallons per minute against a head of 700 feet with the large runner turning at the rate of 2,050 revolutions per minute and the small one at the rate of 20,500 revolutions per minute. The small runner is connected directly to the turbine shaft and the large one to reduction gear shaft.

The two-stage, or compound pump, showed a delivery of from 244 to 373 gallons per minute against heads, respectively, of 781 and 136 feet. The water horse power increased from 12.83 horse power, corresponding to 373 gallons delivered at 136 feet head, to 48.15 horse power for 244 gallons delivered at 781 feet head. The duty in million foot-pounds was a maximum of 48,880,000 for delivery at the highest head and decreased to 41,550,000 for 328 gallons delivery at 494 feet head, and to 18,630,000 for the maximum delivery of 373 gallons at the head of 136 pounds. The steam per water horse power per hour ranged from 40.5 feet for the maximum horse power and highest head to 106.2 pounds for the maximum delivery, lowest head and lowest horse power. This lowest horse power is only about one-fourth of the highest horse power delivered by the pump. Both the electrical and two-stage pumps therefore realize their maximum efficiencies at practically the designed conditions of lift and water delivery.

* * *

LONG FLOORPLATE AND CONCRETE FOUNDATION.

Provision was made in the new addition to the Stilwell-Bierce & Smith-Vaile Co.'s plant at Dayton, Ohio, which was completed last year for a cast-iron floorplate 200 feet long and 15 feet wide along one side of the main section. Some of the horizontal hydraulic turbine settings built by this concern have been 130 feet long when connected up; it is desirable, and the practice generally followed, to connect all these settings and turn them over preliminary to shipping. For this reason an abnormally long and narrow plate was desirable as ordinarily two or more settings could be accommodated at once on such a plate, and one of the extra long ones up to the length of the plate if necessary.



Plan of Concrete Foundation for Floorplate.

The floorplate is built up of cast iron sections, 15 feet long and 5 feet wide, laid crossways on the foundation. Each plate is planed on the top and sides and has four longitudinal T-slots which are also finished at the same time. The T-slots are one foot apart, and the sides are planed so that two adjacent plates form a T-slot between them. The thickness of the plates, which are in box section, of course, is one foot. Perhaps the most novel feature of the floorplate, however, is the foundation. The new shop was built on low ground and considerable filling was necessary to bring the floor level to the required height. Advantage of this condition was taken in the building of the floorplate foundation to provide easy means for leveling it up from underneath. Instead of filling this portion with earth, a concrete wall was built in cellular form, as indicated in the accompanying sketch, the distance center to center of the cross walls being 5 feet, and of the side walls over all, 15 feet. Each plate, therefore, is supported all around on its edges by the concrete wall. Openings are provided through the cross walls so that the underside of any plate is accessible at any time, and should settlement take place at any part, rendering lining up necessary, it can be accomplished by two or three men in short order and without disturbing the machines that may happen to be standing on it at the time.

* * *

In connection with the note recently published on the various uses of skimmed milk, in which mention was made of its use in making a primitive paint, we have been apprised of the information that Portland cement mixed with milk makes a very durable and excellent paint. Three pounds of cement are used to a gallon of milk; the mixture is colored with the desired pigment the same as oil paints.

ELECTRICALLY-DRIVEN PORTABLE TOOLS.

DR. ALFRED GRADENWITZ.

The use of portable tools is advisable and even indispensable in many cases when large and heavy pieces are to be worked or when the design of stationary tools does not allow of the piece being worked to advantage.

The electrically-driven portable drills illustrated herewith were made by the Elektricitats-Aktiengesellschaft vorm. W. Lahmeyer & Co., Frankfort, a/M. These drills may be placed in any position and at any height without regard to the source of power, and the use of variable speed motors allows the speed of the drills to be varied readily by steps. The operation of the drills by means of an electric motor may be effected in two ways, according as the motor with its accessories is either placed on a car and connected to the working machine by means of an adjustable shaft, or else the motor is an integral part of the tool itself.

The adjustable shaft connecting the motor with the drill is provided with two universal joints, and the middle section between the two joints is composed of two pieces—one of which slides within the other. These two pieces are splined and provided with a feather, so that the shaft may be lengthened or shortened. In Figs. 1, 2 and 4 some instances are given of this design, while in Fig. 3 is represented the type in which the motor is attached to the drill.

The mechanical part of the drills represented in Figs. 1, 2 and 4 was built by the firm of H. F. Stollberg, Offenbach. These machines have a vertical column on which a casting for supporting the radial arm of the drill can be adjusted and clamped in any desired position. The drill itself is carried by an arm sliding in this casting. This arm is bored out to receive the driving shaft, and power is transmitted to the drill spindle from the end of this shaft by means of bevel gears suitably inclosed for the protection of the workman. Adjustment of the drill upon the vertical column, and of the radial arm, is in some cases effected by threading the column and the arm and using a large nut which is turned by hand; in other cases by simply sliding one within the other without mechanical means of adjustment.

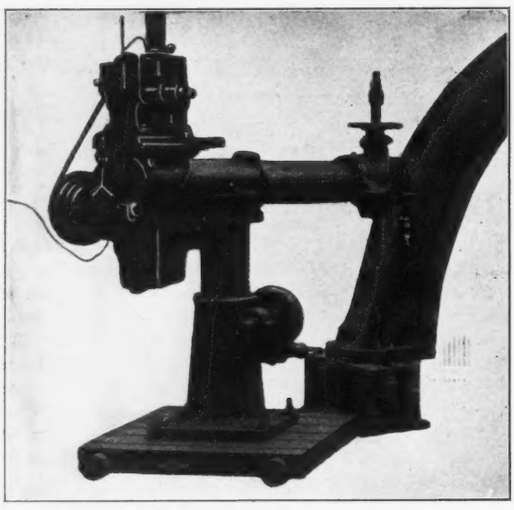


Fig. 9. Drill shown in Fig. 2 on Opposite Page.

The arrangement of the motor on the car is shown in the engravings. The car body is of cast iron and the motor is inclosed by means of a tightly fitting cast-iron cover. The car carries a reel for a coil of insulated wire for transmitting current from the nearest electric socket. As shown in Fig. 4 the handle bars can be removed when it is desired to suspend the motor, with its driving mechanism, from a crane hook.

In Fig. 3 is a small radial drill in which the motor is combined with the drill itself and drives it by a triangular belt running on cone pulleys. This drill was built in the machine shops of Lorenz, Ettlingen, Germany. It has a heavy base in which the column may be adjusted vertically by means of a worm mechanism and rack and pinion. The horizontal radial arm moves in a socket, which latter may either be clamped to the column or may swivel upon it, through a full circle. In the illustration, Fig. 9, on this page, the construction of the drill is shown more clearly. The drill head is at one end of the arm and swivels upon it, while the motor and cone pulley are upon the rear end. Fig. 10, on this page, shows the drill specially adapted for bridge building. It is driven from a portable motor by means of a jointed shaft and the drill weighs only 40 pounds, and may be easily transported to the working place by one man.

The drill head is supported by three legs, which at their lower ends have bell-shaped magnets with covered coils, by means of which the drill is kept in position electromagnetically on the piece to be worked. The legs are made adjustable, allowing the machine to be adapted to the conformation of the work to be drilled. After fixing the legs in position the drill may still be shifted in a vertical direction without changing the position of the magnets. The jointed shaft may be connected either directly to the drill spindle itself or to an auxiliary horizontal shaft geared to the spindle, and by this means two different speeds are insured, adapting it to holes of either small or large diameter.

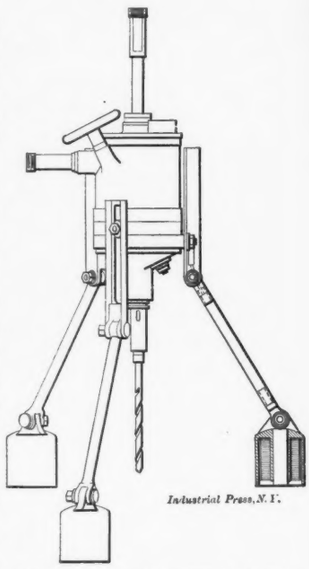


Fig. 10. Drill with Solenoid Tripod.

Another drill of similar type is made by the Lorenz shops for drilling armor plate. This, in like manner, has the three legs, but the frame of the drill has a cross rail so that the drill head may be shifted laterally after the magnets have been fixed in position, thus making the machine adapted for drilling several holes in a row. In this case the motor is attached directly to the drill head, and has a safety switch which throws out automatically when there is an overload, thus preventing breakage of the drills.

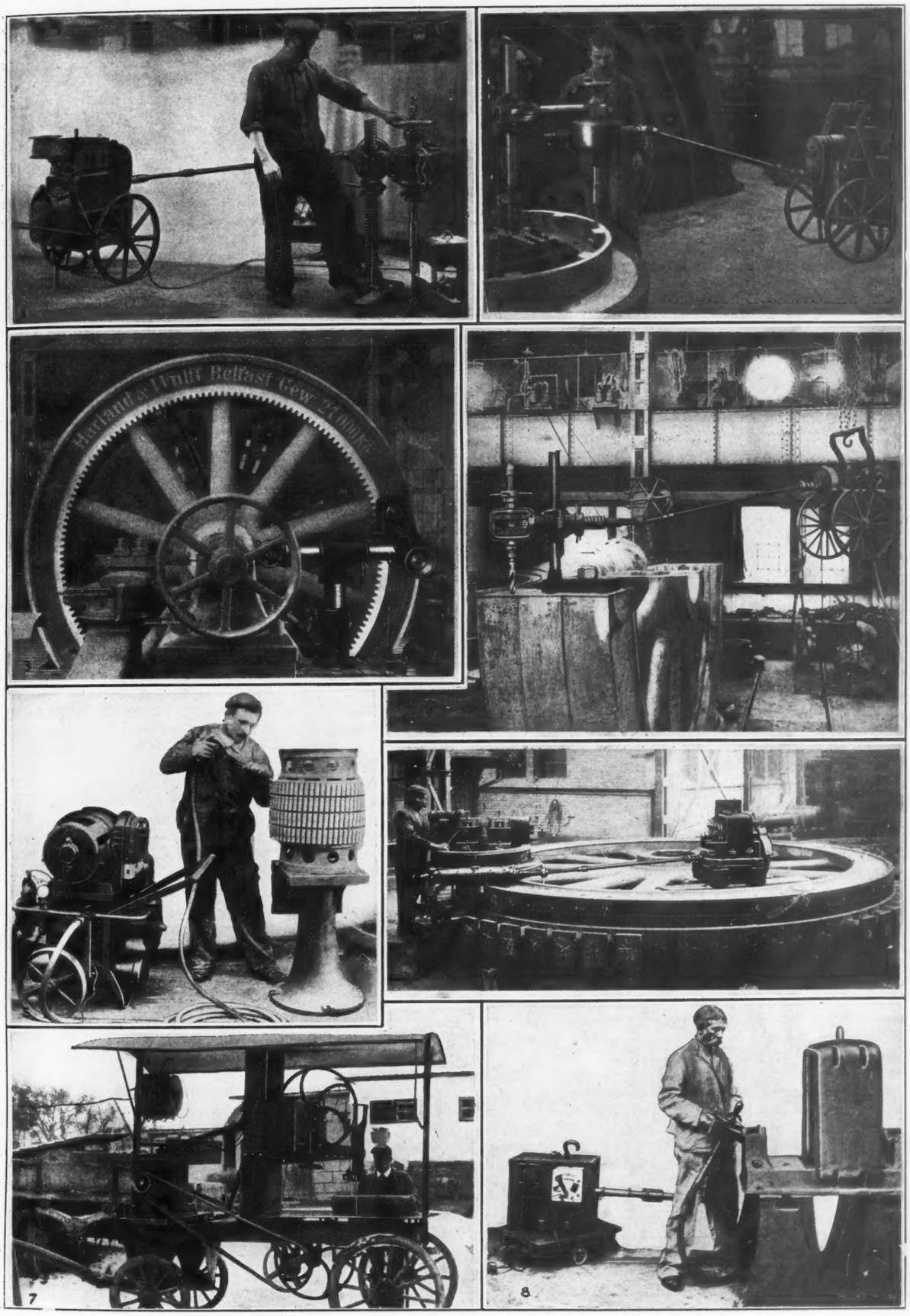
The use of compressed air tools as, for example, pneumatic hammers, chisels, etc., is being more and more widely adopted in Germany. In Fig. 5 of the group is a portable electrically-driven compressor of the Maschinenfabrik Aktiengesellschaft vorm Justus Christian Braun, for driving such tools. The compressor with its motor is mounted on a car of simple construction. The motor is a direct-current motor built by the Lahmeyer Co. The commutator of these motors is accessible through openings in the shield-shaped bearings, susceptible, however, of being closed. As the starting devices for the motor and the fuses are also located on the car, the whole becomes a homogeneous machine, requiring only hose connection with the compressed-air tools to be used anywhere. It is adapted to machine shop use with electric power transmission and renders tools independent of a special compressed-air plant.

In Fig. 6 of the group is shown a rotating device for turning ring-shaped grooves in flywheel rims over which circular rings are to be shrunk for holding the sections of the rim together at the joints. This is also driven by a jointed shaft from a portable motor.

Two more applications of portable tools are illustrated in Figs. 7 and 8. Fig. 7, though hardly a machine shop tool, is nevertheless of interest as being a convenient type of portable band saw which carries its own coil of wire for connection with the nearest available electric current. Fig. 8 is the familiar emery wheel and flexible shaft driven by a portable motor. The motor is thoroughly protected by a perforated metallic casing.

* * *

Pure iron does not exist in nature and so difficult is it to produce pure iron that some one has said that it may properly be classed as one of the "rare metals."



Group of Electrically-driven Portable Tools built by Foreign Firms. (See Opposite Page.)

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MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

AUGUST, 1904.

NET CIRCULATION FOR JULY, 1904,—21,611 COPIES.

MACHINERY is published in three editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a complete review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering, but is printed on thin paper for transmission abroad.

THE MILL TYPE OF CONSTRUCTION.

The mill type of factory construction, which has been developed to its fullest extent in the immense cotton mills of New England, probably combines more features that are necessary or desirable for a manufacturing building than any kind of multi-storied structure. The only type that can be claimed superior in any respect is that embodying modern steel-concrete construction, with the steel covered by fireproofing material, and with re-inforced concrete floors. This type is more expensive, however, and it is not certain that it is any better than the regular mill type. Certain points embodied in mill construction are brick walls with large windows and pilasters to stiffen the walls; floors several inches thick, of plank, tongued and grooved together, with hardwood flooring laid on top; massive floor timbers, spaced widely apart, and left exposed, without any overhead covering; and rows of columns, preferably of timber, for the support of floor beams at the center of the building. Stairs, elevators, etc., must be in a separate brick tower, connecting with the main building by fireproof doors. Floors must be intact, with no openings through them. The automatic sprinkler must be in evidence and other means taken for protection against fire, and above all for fire prevention, following methods in these respects that have proven their worth in actual trial.

Mill construction, so called, is the result of a demand for a substantial structure at a comparatively low cost, with fire-resisting qualities of the first order, insuring protection to both products and machinery from damage by fire or water. In its most approved form it is a development that has come about through the efforts of mutual insurance companies, and it is rightly understood to comprehend a due regard to equipment and arrangement, with a view to reducing the fire risk, as well as a definite system of construction of the building proper. The features of strong, massive and simple construction are inseparably linked with the slow-burning and fire-preventive features in the modern mill type.

As a model example of what a mill type building can and ought to be, we are glad to present the description this month of the new plant of the New Britain Machine Company. The main building of this plant is as fully protected from fire dangers as it is possible, probably, for any building to be; its arrangement is convenient, it is well lighted and well equipped. Moreover, we think the description will be of rather unusual interest because the plant is of moderate size, like the majority of shops in this country, and so is more nearly representative of the average needs than a more imposing array of buildings would be. Descriptions of establishments of immense size, while of interest, are meaningless to the average person, because the average person does not expect to have the opportunity to become personally identified with such a plant.

* * *

The average American boy and grown-up only thinks of the elephant synonymous with the circus and pink lemonade; in India, however, the elephant is more highly regarded. It is a most invaluable labor-saving machine and one endowed with remarkable intelligence. The July issue of *Cassier's Magazine* presents an article "The Elephant as a Machine," accompanied with illustrations showing characteristic work for which these huge beasts are trained. The hauling of heavy machinery, building highways, piling lumber, treading clay for brick-making, are some of the uses to which they are put. The author says that the elephant appears at all times to comprehend the purpose and object that it is expected to effect; herein lies its superiority over the horse. The elephant voluntarily executes many details of its work with no guidance from its keeper. In moving a stone an elephant will step around and view the stone from either side and then adjust it with due precision, etc.

* * *

ASKED TO ANTE-UP.

The Massachusetts Institute of Technology is the largest, and one of the oldest technical institutions of learning in the country. Like other institutions, however, not blessed (?) with a heavy endowment, the possibilities in the way of extension by broadening and adding to the courses of instruction, enlarging the laboratories, etc., are always just a little in advance of the means at their disposal for doing such work. The institution, therefore, while maintaining the extremely high standard for which it is noted, is habitually in somewhat straightened circumstances.

At the same time a princely gift of $5,000,000 has recently fallen to Harvard University from the Gordon McKay estate, left by the noted inventor of shoe machinery, with the positive stipulation that it shall be used for technical instruction. Harvard has its scientific school, but it has been devoted to purely scientific subjects, in the main, rather than to instruction in the arts; and as it would seem like a waste of resources to establish a new technical school of great proportions so near the Massachusetts Institute of Technology, there has naturally come a discussion of the possibility of a union between the two institutions in some form or other, with a view to diverting part of the McKay funds in favor of the Boston school. The latter would then allow its students to avail themselves of the opportunities for scientific study at Harvard and would also receive Harvard students for instruction in technical subjects in return.

At a recent reunion of the alumni of the Massachusetts Institute of Technology, however, when the matter was extensively discussed, the sentiment among the past students was very pronounced as entirely opposed to any action of this kind. It was held that the Institute had acquired its own individuality, that there had been men associated with it who had stood for much in the industrial and scientific world, and that it was desirable on every account to preserve these characteristics and associations without regard to monetary considerations. Such a feeling for one's alma mater, akin, perhaps, to a feeling of patriotism, is a very noble sentiment to have, but it naturally has led the corporation of the Institute to wonder to what extent this expression of loyalty is the "real thing," and to what extent it is superficial and only for effect. In other words, they think it eminently proper that such exuberant expressions of feeling should be backed by hard cash and so each alumnus has been asked to step forward with a liberal contribution to ensure the future independence of the Institute. Sentiment is undoubtedly the greatest thing in the world—provided it goes deep enough to affect the pocket book.

AUTOMATIC SPRINKLERS ON SHIPBOARD.

The bits of wisdom that have been handed out by the technical and daily press on the question of safety in marine travel, since the burning of the ill-fated *General Slocum*, in which over 1,000 lives were lost, would, if gathered together, make a wonderful compendium. MACHINERY has even been the recipient of letters telling what "ought" to have been done and what "ought not" to have been done in the matter.

A contributor to the *Newark Evening News*, however, has made a suggestion which seems to indicate, at least, the direction in which safety for marine passengers is to be expected. He contends, in brief, that the same precautions and provisions against fire should obtain on sea as on land and what has proven effective means for the prevention of fire on land should be adopted on shipboard. One of these means is the use of the automatic sprinkler, and he believes it should be and can be applied on shipboard as well as in factories.

In another column we have called attention to manufacturing buildings of the mill type, which are of slow-burning construction. Such buildings have not come all at once. They are a development and are the result of the education of the public. In a manufacturing building, even of poor construction, there would be a hundred chances for the occupants to escape in case of fire where on shipboard there would be one chance. Yet the worst building of this kind is scarcely more of a fire trap than the flimsy superstructures on shipboard. While the latter are protected, to a certain extent, by fire-fighting apparatus, they are not provided with one-quarter the protection that is now considered essential in a modern manufacturing building, storehouse or department store. We do not believe that a change for the better can be brought about in a day; it must come as a development, through education, and it is about time that the insurance companies, government authorities and others of influence should start the primary course. As an illustration of the need of this, on the day following the burning of the *General Slocum*, a contract was awarded by New York City for five ferry boats to ply between Manhattan and Staten Island. The new boats are to have steel hulls, but the superstructure will be of wood —flimsy painted pine—designed substantially like the prevailing style for ferry boats. How easy it would be to use instead a light steel superstructure and to equip the vessels with automatic sprinklers. The trip that these boats have to make is a comparatively long one, and during the rush hours they will be as crowded as an excursion boat. It would seem as though the public which has to patronize this line would, in view of the dreadful lesson of the *General Slocum*, demand that safer boats be furnished them. Yet we have not heard of any such action being taken, and it probably will not be—because the public has not yet been educated.

* * *

TO EUROPE IN SIXTY HOURS.

When we wrote last month of the efforts of inventors to improve marine craft by circumventing the laws of displacement and friction, we did not know that an effort in this direction is in progress, almost within stone's throw of our office. None other than a hardy captain and mariner, who has sailed the seas for many years, is the inventor and he is now building a vessel which he describes as follows:

"The hull is divided in three sections, running lengthwise, with deep grooves between. Instead of plowing the water, as the ordinary hull does, having tons of resistance to overcome, these grooves allow the water to pass right through the hull, and the resistance is reduced to a minimum. Then I propose to have the propellers, three in number, in the forward part of the hull, instead of at the stern."

We do not think the captain has gone far enough. Cutting grooves through the hull will let only part of the water through. Why not cut away the hull entirely and let the vessel float on the surface of the bounding billow and draw as little water as possible? This would let the greatest possible amount of water "through the hull" and the captain would then have a raft—a type of vessel not noted for its speed, but which, according to his philosophy, should attain a wonderfully high rate of locomotion.

In talking about his invention, the captain says that the Deutschland, for example, if fitted with hull and propellers of his devising, would cross the ocean in half the time of her present average voyage and with a fuel consumption of 50 per cent. of her present cost for coal. The technical editor of the *New York Times* has gotten together some figures on this, however, which look a little discouraging. The Deutschland has a gross tonnage of 16,000. Her maximum midship section is about 1,936 square feet. Her indicated horse power is 37,500. Her best service record is 24.19 knots per hour. The distance between New York and Liverpool is 3,540 miles, or 3,070 knots. To make it in sixty hours the captain's boat will have to average about 51 knots an hour. To do this the Deutschland would have to be provided with 300,000 horse power of engines and burn approximately eight times as much coal as she now consumes per voyage. This is the practical side of the problem of the 51-knot speed. No doubt that speed is attainable for short distances in a specially-built boat in which carrying capacity and cost are of no account, but something more than a catamaran would be needed to float the engines and carry the fuel.

* * *

It is sometimes difficult to decide whether it is better to generate power in close proximity to the point where it is to be used, or to concentrate the power at a single point and then distribute it by some one of the methods of power transmission. Such questions frequently arise in respect to the use of power in mines or factories, but it is not often a point for serious consideration in a simple machine. Two incidents have come to our attention, however, in regard to the arrangement of the propelling machinery of an automobile where the question of power transmission is an all important one. Two inventors —and perhaps many more, though we have not heard of them —have been working independently in different parts of the country upon the same problem. They are trying to produce a steam automobile with engines acting directly on the hubs of the wheels, thus dispensing with intermittent gearing, universal joints, differential gears, etc. Both have adopted the scheme of using two three-cylinder motors, carrying the steam to them from the boiler located in the body of the vehicle. The advantages, of course, are those that accrue from direct driving and simplicity of parts; while the disadvantages, though less obvious, will appeal strongly to anyone who has had to do with questions of steam distribution. Steam has the habit of converting itself into water under any and all opportunities, and this act represents, usually, a lot of valuable heat units gone to waste. The place to condense steam is properly in a condenser, and it is not in accordance with modern methods to make a condenser out of an engine cylinder, and this principle evidently holds in automobile work as well as in any other. Two multi-cylinder engines, located where they will catch all the air that blows, and connected with the boiler by long pipes, would make ideal condensers, but scarcely an ideal installation of steam machinery, judged by general principles. The idea of locating the power next to the work in an automobile is not a bad one, provided the power is of the right kind. It will be remembered that an electric automobile truck having this feature was illustrated in the last number of MACHINERY. But here the case is different. The losses from subdivided electric power are small, and the losses from transmission are almost nothing.

* * *

One of the drawbacks of country life to those who are accustomed to the conveniences of city life, is the lack of running water in the house. This means no bathroom, a limited supply of hot water, and no water under pressure for sprinkling, etc. A tank in the attic is a source of danger from freezing and flooding the house, and is generally objectionable. Compressed air, however, has solved the problem, and made possible a water system in the house in isolated communities. A closed tank is buried in the ground and connected to a force pump driven by power, usually a wind-mill. The imprisoned air in the tank compresses and maintains a pressure on the water sufficient to force it into all parts of the system, giving it a head due to air pressure instead of coming from a higher level.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

A recent patent, says the *Mining Reporter*, covers a novel use for copper in the manufacture of an anti-fouling ship's paint. The surface to be treated is coated with a quick-drying paint and finely-comminuted copper is blown into it. This surface is burnished and a second application of still finer copper is continued until a surface of copper is obtained.

We have no doubt that many draftsmen will be interested in the way blueprints are (not) made, as intimated in a story in the June issue of the *Ladies' Home Journal*. The hero visits an architect's office with his rough plan of a house, and finds that the architect is already committed to nine, "of which an amazing number of young men were drawing the details in white ink on sheets of blue paper!"

Hadfield's manganese steel is a unique product, says Mr. William Metcalf in a paper, "Alloy Steels," read before the June meeting of the American Society for Testing Materials. It is hard, tough, non-magnetic, non-hardening by quenching, non-annealable by any known method, and is practically unmachineable. It stands in a class by itself, for there is nothing to compare it to, nor to test it by. However, it is being used for a large number of special purposes.

A stone viaduct is being built at Plauen, Saxony, over the River Syra, which contains the longest masonry arch in the world, its length being 295 feet 3 inches, measured horizontally from base to base. The new bridge will be opened to traffic about November 1, 1904. The Luxembourg bridge across the valley of Petruffe, which was completed a few months ago, has a span of 277 feet. The next longest masonry arch is in the United States, near Washington, D. C., and is known as the Cabin John bridge. Its length of span is 220 feet.

An instance of a great invention being made and allowed to drop into obscurity to be reinvented later, is, incidentally, mentioned by Mr. Andrew D. White in the July *Century*. More than forty years ago, while with friends examining curios in the Imperial Museum at St. Petersburg, they found among the relics of Peter the Great, a lathe for turning irregular shapes and another for copying reliefs. These machines had been built for Peter by some ingenious mechanic from Holland fully one hundred and fifty years before and perhaps one hundred years before the date of Blanchard's famous invention.

The United States consul at Frankfort, Germany, says that aluminum is being quite successfully used in some of the foreign textile mills for making bobbins, in place of wood, which has been almost universally used for that purpose heretofore. Wood being very hygroscopic, gives more or less trouble in the spinning room on account of changes of weather which causes the wooden bobbins to run irregularly. The aluminum bobbins run smoothly in any weather and they are much lighter, five aluminum bobbins weighing about the same as two wooden ones. This difference in weight is said to make quite a difference in the economy of operating textile machinery as considerably less power is required for the production of the same amount of cloth with the lighter bobbins.

A great deal of thought and effort have been expended upon the recovery of tin from the vast number of tin cans and the tons of tin plate scrap that are annually rejected. Mr. John B. C. Kershaw reviews a number of the processes in the *Electrical Review*. The Germans lead in this work and may be said to almost monopolize it. They have eight factories which treat tin scrap electrolytically and reduce about 30,000 tons annually. Much of the tin scrap of this country goes to Germany and in 1898 it brought as high as $5 a ton in New York. Tin scrap contains on the average 3.5 tin and 96.5 iron. The great drawback to the successful prosecution of this enterprise is the large proportionate cost of collection and freight.

In a paper read before a Scottish mechanical society in Aberdeen, the assertion was made that mineral or vegetable oils should never be used on leather belting. Castor oil soon causes leather to rot and waste away, but linseed oil is excellent to use on cotton belts as it soon oxidizes and gives the belt an elastic gummy driving face. Leather belts should be treated with fish oils and animal fat mixed to the consistency of a soft ointment, which should be spread on both sides of the belt with a broad brush. A belt so treated can be made to transmit its maximum driving capacity without slip while running slack, and running in that way the trouble of hot bearings and overstrained belts is avoided.

In the April, 1901, issue a large lathe for turning granite columns was described, which was specially built for one particular job—that of turning the 130-ton columns for the cathedral St. John the Divine on Morningside Heights, New York City. In the description, it will be remembered, the statement was made that the cathedral had been building several years and that many more would elapse before it was completed. As an indication of the length of time that will probably elapse, it is interesting to note that the first of the granite columns was just erected, June 27. The original plan of making the columns monoliths was abandoned on account of the difficulty of turning such long heavy masses in the lathe, and they were finally made in two parts, weighing about 90 and 40 tons each.

The temperature of combustion of nitro-glycerine compounds or powders containing a large proportion of nitro-glycerine is said to be higher than the fusing point of steel. Hence the deteriorating effect of such powders on the bores of heavy guns. At each discharge a thin layer of the bore is actually fused and carried away with the discharge, which accounts for the rapid erosion of guns using such powders. The temperature of the nitro-cellulose used by the United States Government is considerably lower than that of the nitro-glycerine compounds, and consequently the erosion of our guns is much less than of British guns for the same number of discharges. For this reason perhaps more than any other the British Government is abandoning the use of nitro-glycerine in favor of nitro-cellulose.

At a recent meeting of the North Staffordshire Institute of Mining and Mechanical Engineers Mr. William Lockett read a paper describing the failure of a "lock-coil" winding rope 1¼ inches in diameter, 1,460 feet long, weighing 5,880 pounds and having a theoretical breaking strength of 156,000 pounds. The average load carried by the rope when hoisting was 12,500 pounds. Six broken wires were found in one place and five in another, but fortunately the defect was discovered before an accident occurred. Owing to the peculiar construction of lock-coil wire rope the author intimated that the outer strands, or those forming the lock-coil, were subjected to a greater stress than those forming the core, there being, it is believed, a lack of the mutual grip of the strands as found in ordinary wire rope. Another fault found with the construction is the difficulty, which amounts to a virtual impossibility, of lubricating the inner wires.

A funny tale comes from the South, according to the *Electrical Review*, telling of the sad experience of a telephone subscriber who attempted to repair his transmitter. Finding some difficulty with his telephone, this self-appointed repair man undertook to put it in order, but not with entire success, for upon taking apart the transmitter, the granulated carbon was spilled upon the floor and some lost. An examination of what was left convinced the would-be expert that the grains were nothing more than gunpowder. Consequently, when putting the instrument together again, he used gunpowder to replace the lost material. After finishing the job to his satisfaction, he attempted to call up the exchange, so that he might

ascertain how successful his work had been, not thinking that now his transmitter was loaded; but, upon ringing the magneto, the gunpowder in the transmitter exploded, with some damage to the subscriber's face, and disastrous effects upon the telephone.

A New York patent firm has passed into the hands of a receiver, and in the application made to the court it was asserted that the inventive genius of the country is waning. In 1901 the company made a lot of money, but in the year following, the fertility and inventive genius of the country seemed played out, and there were but few really commendable and money-making patents filed in Washington. While it may be true that there has been a marked falling off in the number of good patents granted during the past two years, it can scarcely be consistently held that this diminution is due to lack of inventive genius. It is more likely caused by the general tightening up of money affairs and the falling off in trade. The most profitable patent business is that of large concerns developing new machines and processes, and these concerns, of course, do not take out as many patents when they are doing a small amount of work as they do when a great deal of new business is coming to them.

The United States consul at Birmingham, England, reports that some of the tube-making mills in his district are being "Americanized," skilled tube makers having been imported from Pittsburg and vicinity to reform the British system of tube making. The consul remarks that the men are brought over under five, three and one year contracts at wages several times greater than the ordinary wages paid in the Birmingham district, and at an advance over the wages paid for such labor in the Pittsburg district, but that there are some disappointments in store for them. In the first place the common impression abroad that living is cheap is erroneous—that is, on the scale to which the average American workman has been accustomed. Food and clothing are dearer than in the United States, and it is difficult to find houses with modern conveniences for rent that are within the reach of the imported workmen and near the works. Moreover, the imported men have to pay a good big income tax—something that they had not calculated on when accepting the job.

A scheme, undoubtedly new to many, for the delicate statical balancing of armatures and other revolving parts, is illustrated in the July issue of the *Electric Club Journal*. The shaft supporting the armature is not laid directly upon the balancing ways, but is encircled with a hardened steel ring at each end, which has been accurately ground and polished. The shaft and the rings roll together upon the ways, and, although these rings do not fit the shaft, they make the balancing test perceptibly more sensitive. When a soft steel shaft carrying a considerable weight is laid upon the balancing ways, there is some local deformation at the points of contact that tends to make it lie in whatever position it happens to be. With the hardened rings around the shaft this local deformation is largely neutralized; the rings being hard do not change shape so much as a steel shaft in contact with the ways, and the shaft itself bears on the inside of the rings where it is supported by a considerably greater area of contact, even when the rings are two or three times larger than its diameter.

The legend, "Patented September 18, 1894" (or any other date) stamped on any device or machine, gives little intimation of how broadly or how narrowly the principle is covered. Very few patents cover broad principles of operation or construction, and many patents are granted for ideas centuries old but modified, perhaps, to suit new conditions or thinly disguised to fool the examiner. A case in point is a spiral conveyor for carrying grain, granular matter or liquids, which is being exploited as a patented device and one superior to the ordinary type of screw conveyor, having a stationary shell and a revolving worm. The "new" conveyor consists of a pipe forming the shell, having a shallow internal flange riveted in a spiral. As the pipe revolves the contents are traversed in the direction of the lead of the spiral. This, of course, is essentially the Archimedean screw (without the central shaft), familiar to every school boy who has studied physics, and confessedly as old as Archimedes (212 B. C.) and probably much older. Nevertheless, it is a good idea and probably will prove valuable for the purposes designed.

In its description of the new White Star steamer, the *Baltic*, the *Scientific American* states that it is the first mercantile vessel to be equipped with the safety indicator used in the British Navy to show the approach of other vessels and thus prevent collisions. This device is placed on the bridge, and it indicates the exact position of any other vessel entering its magnetic zone. .There is a dial carrying a needle on its face similar to a compass. As soon as the other vessel enters the magnetic zone, the radius of which in this instance is five miles, the needle revolves and points directly toward it, thereby indicating its precise location. This apparatus is highly sensitive, and even the screw revolutions of the approaching vessel are registered by the wave vibrations. In this manner the officer on the bridge can estimate the exact line he is distant from the other vessel, and act accordingly so as to clear it. With this precautionary device it is absolutely impossible for another vessel to creep up even in foggy weather or under cover of darkness without the officer being aware of its approach.

The *English Mechanic* says that a new instrument for measuring areas consists of a plate of glass on which are engraved a dozen or so graduated lines radiating from one center, the outer lines lying at an angle of 40 degrees. If any closed figure, such as an indicator card, be placed so as just to touch each of the outer lines, all the other lines will cut the figure at two points, and the sum of the interior readings subtracted from the sum of the exterior readings will give the area in square inches of the figure. Tested on a circle and on a triangle (equilateral), the errors did not exceed 0.07 and 0.02 per cent., and the error with indicator diagram is less than the error of the indicator itself. This convenient and cheap substitute for the planimeter was exhibited at the Royal Society soirée by Mr. R. W. K. Edwards.

Another device for the same purpose, designed by Prof. D. A. Low and sold by Longmans, Green & Co., consists of a piece of transparent celluloid printed with ordinates and abscissæ which are numbered. The use of this instrument is apparently not nearly as simple as that of the foregoing and cannot be intelligently explained without the use of diagrams.

Proprietary rights in trade marks are often exceedingly valuable, but the status of trade marks is often very vague and unsatisfactory. For instance, it is a department ruling that a trade mark shall not express a quality. That is, for instance, "Neverleek" could not be used as a trade mark for tinware as it would convey to the buyer an impression of quality which in all probability it could not possess. Hence the department refuses to sanction proprietary rights in descriptive trade marks. But trade marks have been issued which do unquestionably convey the impression of some desirable quality, which is an indication of the uncertainty of the regulations. Again in the United States, we do not hold that the mere use of numerals or letters in any particular order can properly constitute a trade mark, unless blended together in some arbitrary design. A recent consular report from Birmingham, however, gives an instance where the sole use of the letters "B. S. A." by the Birmingham Small Arms Company is upheld in a German court in opposition to its use by a German concern who were applying the same combination of letters to a line of cycle fittings, accessories and component parts which had no resemblance to the goods manufactured by the plaintiffs. The defendants are restrained from using "B. S. A." under penalty of $357 or imprisonment for six months for each violation, and had to pay all costs besides putting up a bond of $3,570 to secure the proper observation of the terms. This is believed to establish an important precedent.

Compressed air for the transmission of power has a field peculiarly its own, which probably it will always be able to hold against all comers, *i. e.*, the working of quarries and

mines, and wherever the use of reciprocating tools is advantageous. But many compressed air plants have been installed giving an undeniably low efficiency for the coal burned under the boiler. One fruitful cause of loss is taking the air supply from the engine room, where the temperature may be 30 or 40 degrees higher than the external air. When it is considered that every 5 degrees increase of temperature of the air supply means, approximately, a loss of 1 per cent. in efficiency of air compressed it would seem that this cause of loss would always be avoided, but strange to say it is not. In addition to taking the air supply outside the engine room it is possible to go a step further and cool the air before it enters the suction pipe by circulating it through running water. The *Engineering News* gives a description of the compressed air transmission plant of the Cleveland Stone Company in which this is done. Air washers are placed at the mouths of the intake pipes to serve the double purpose of cooling the air and removing all dust and grit. Each washer contains 600 vertical pipes set in a box or tank with their lower ends immersed about 2 inches in running water. The intake air is drawn through the tubes, down through the water which is constantly changing. Not only does this remove the dirt and cool the air but it removes a considerable portion of the water or vapor in the air, because as air is cooled its capacity for moisture is reduced. The consequence is that no trouble from freezing of drills or motors has been experienced in this quarry even in the coldest winter weather.

CARBON VS. METAL BRUSHES FOR DYNAMOS.

A writer in the *Electrical Review* (London) asserts that the one redeeming feature of the carbon brush for dynamos is its non-sparking tendency, which, in his opinion, does not compensate for its bad features. The carbon brush practically necessitates large commutators and extra expense of brush gear, large shafts and longer machines, and therefore, must increase the cost of production by a large amount. Especially is this the case where large currents have to be dealt with. This practice results from the designer's doubt of the efficacy of metal brushes. Carbon brushes not only increase the first cost, but lower the efficiency, so that it frequently happens that this might be increased 2 or 3 per cent. by the use of metal brushes. Consulting engineers demand carbon brushes, unmindful of the fact that so long as sparkless commutation is secured it is immaterial of what the brush be made. Comparing the design of a commutator for a six-pole 88-kilowatt parallel-wound armature for carbon and for metal brushes it is found that the use of carbon necessitates three times as many brushes as the metal. For the former the commutator must be 17 inches long, and for the latter only 6. The watts lost, due to the friction of the carbon brush, number 1,025, as against 205 for metal. The watts lost, due to the resistance of contact of the former, are 1,260, as against 434, making the total loss 2,285 watts for carbon and 639 for metal. The watts lost per square inch are 2.51 for carbon and 2 for metal. The commercial efficiency with the carbon brush is 91.8 per cent.; with metal, 93.4 per cent. The chief virtue of the carbon brush is its high specific resistance, which facilitates sparkless commutation. To secure a similar condition with metal brushes they may be subdivided with an insulating partition between the portions; or the central layers of metal may have a higher specific resistance. Where a reversible motor is employed a radial brush is necessary, but it would not be impossible to construct a satisfactory brush of this type out of metal.

THE ACETYLENE SAFETY STORAGE SYSTEM.

Railway Critic, July, 1904, p. 180.

The recognized advantages of acetylene gas as an illuminant make the discovery of a safety storage system one of great general interest, especially to railway and steamship companies. The reasons for preferring acetylene as an artificial illuminant may be briefly stated as follows:

1. The quality of the light is more nearly like sunlight than any other artificial illuminant. It is not only specially adapted to interior illumination, but gives the most satisfactory results in running lights, as well as in searchlights of high power and penetration.

2. The quantity of acetylene ordinarily used in a gas jet is one-tenth that of an ordinary burner used with the best city gas, and with fifty per cent. more candle power. For example, an ordinary burner with the best city gas consumes not less than 5 cubic feet per hour and gives 24-candle power; whereas, the burners generally used with acetylene consume one-half of one cubic foot (one-tenth of the quantity), and give 26-candle power.

3. It is safer than any other form of lighting, because of the small quantity used. A jet carelessly left open would not emit enough gas, even in a small room during an entire night, to cause asphyxiation or to produce an explosion. The strong pungent odor of acetylene will instantly make apparent any leak that may occur.

4. The small quantity of gas burned (one-half of one cubic foot per hour) makes a small compact flame which cannot be blown out, even in a gale of wind, and which therefore can be used out-of-doors as readily as an electric lamp. At the Pan-American Exposition at Buffalo, N. Y., in 1901, the outside of an entire building was decorated with acetylene jets, which burned in the open air in all kinds of weather, and which were not affected by gales or rain; while their great brilliancy added perceptibly to their decorative effect in comparison with the adjoining buildings, the exteriors of which were decorated by electricity.

5. Until recently, acetylene has been used only in direct connection with generators, the use of which is objectionable on account of the space occupied. Notwithstanding this a large number of European yachts, both sail and steam, and other marine craft have already adopted acetylene. In England many of the steam yachts have thrown out their electric light plants and substituted acetylene as a matter of convenience and luxury; and as a matter of economy, a large number of the English Channel fishing fleet are using acetylene instead of oil.

The system which has already been successfully introduced in this country by the Commercial Acetylene Company, has two salient features; first, the use of porous brick or asbestos with which the tanks are filled, and which insures absolute safety; and, second, the use of acetone in combination with the acetylene. Exhaustive experiments in France, and also in this country, have demonstrated that when acetylene is compressed in a tank that has been previously filled with porous brick, asbestos or other porous substance, it is impossible to produce explosion even when an electric spark takes place inside the tank filled with acetylene under high pressure. Hence the introduction of porous brick or asbestos renders this system the safest in use. The pressure employed in ordinary practice is about one-seventh of the pressure to which the cylinders or tanks are subjected under test. The margin of safety is therefore greater than in any steam boiler in use, and leakage or explosion is a practical impossibility. The second feature of this system is the combination with acetone, a well-known, harmless and inexpensive drug, common in commercial use. By extended scientific experiments it was discovered that by saturating the brick or asbestos with acetone the capacity of a cylinder or tank of a given size and under a given pressure is increased tenfold. Hence the ordinary railway car cylinder (10 feet 4 inches long by 20 inches diameter), having a normal interior capacity of 22 cubic feet, will hold 220 cubic feet of ordinary city gas at 150 pounds pressure; whereas, when charged with brick and acetone, this same tank, with the same pressure, will hold 2,200 cubic feet of acetylene. Such a tank would contain sufficient gas to supply an ordinary railway car from New York to San Francisco and back four times without recharging; whereas, with the gas in common use, the same tank would require recharging every day or two, en route. Two or three such tanks of light weight would occupy insignificant space, and would supply a large sailing ship with ample light for one year without recharging.

The work of piping for acetylene is very simple. Inasmuch as the quantity of acetylene required to supply a given number of lights is one-tenth of the quantity required with ordinary gas, the size of diameter of the pipe used is very much smaller than the ordinary standard ⅜-inch gas pipe. A pipe of the diameter of a common lead pencil, or about the size of an

ordinary insulated electric light wire, will be sufficient. This pipe is made of brass; and, where it is not practicable to conceal it, may be run in a cornice or molding in such a manner as not to be unsightly or otherwise objectionable.

The vitiation of the atmosphere by the consumption of oxygen is, of course, directly in proportion to the volume of acetylene used, and therefore about one-tenth as compared with an ordinary five-foot gas burner. The heat of an acetylene burner is also proportionate to the amount consumed. It has been estimated that an ordinary 16-candle power incandescent electric lamp gives out about one-eleventh of the amount of heat of a five-foot gas burner. As the acetylene burner consumes only one-tenth of the amount of gas consumed by a five-foot burner, the amount of heat given out by an acetylene burner is a very little more than that of an ordinary incandescent electric lamp.

ALLOY STEELS.

Abstract of Paper Read by Mr. William Metcalf before the American Society for Testing Materials at the Atlantic City Meeting, June, 1904.

Self-hardening or air-hardening steel derives its name from the fact that when it is heated to an orange color and allowed to cool slowly in the air it becomes exceedingly hard. Some years ago it was known generally as Mushet steel, from the fact that its first development was due to the distinguished metallurgist whose name it bore. The usual composition of this steel is about 2 to 3 per cent. manganese, 4 to 6 per cent. tungsten, and carbon high.

The distinctive, persistent hardness of manganese steel indicates that it is manganese that gives this steel its so-called self-hardening property. This was confirmed many years ago by Langley, who found that steel high in carbon, containing about 4 per cent. tungsten and minute quantities of manganese, had no self-hardening property, and that the same steel remelted, so as to contain 3 per cent. manganese, became an excellent self-hardening steel. Langley next showed by his beautiful emery wheel test that tungsten is the element that acts as a mordant to hold the carbon in solution at a high temperature, giving this steel its most valuable property, that of remaining hard at a comparatively high temperature, so that a tool made of it could be used for cutting metals at a high speed, the tool continuing to do its work at a temperature, caused by the enormous friction of the high speed, that would soften completely and render useless the best carbon steel tool that could be made. This very useful variety of steel has a large place in the markets, being used for many purposes where its peculiar properties give it great value. It is being rapidly overshadowed, however, by the latest and most surprising steel of all, known as "high-speed" steel.

Air-hardening steel, as a rule, is not tough—that is to say, if it is made tough it will not be very hard. The edge of a tool will flow, and when it is so hard that it will not flow then it is so brittle that it will crumble easily, and this limits its usefulness. A few years ago, at the Bethlehem Steel Works, some person—whether he was a blunderer or a genius history does not say—revolutionized the whole machine business. Either by design or accident he heated a tool made of air-hardening steel until it was nearly melted, and according to the traditions and teachings of the ages the tool was ruined utterly. Again, either by accident or design, this "ruined" tool was put into service, and to the amazement of everybody it did an unheard of amount of work. This led to further experiments and tests, and the Taylor-White process was developed.*

This process consisted in heating a tool excessively hot and cooling it by successive stages, producing a tool that would cut at enormous speed for metal work, and take off chips that developed enough heat to blue them. The process was patented, and therefore it is not necessary to go into a long explanation here, especially as it has been superseded. The process seems to have been uncertain—that is to say, when a tool was handled just right it produced results that were wonderful, and when the manipulations were not exactly right the results were *nil*.

The potentialities were so great that nearly all of the leading steel makers in the world attacked the problem, with the result that the present high-speed steels are in no sense of the words air-hardening. Manganese has been reduced from 3 to 4 per cent. to 0.30 per cent. to traces; tungsten has been increased to 10 to 20 per cent., instead of the usual 4 to 6 per cent., and the carbon is generally less than 1 per cent.

There are about 50 different brands on the market, and of course each one is the best. Perhaps the analyses of two of the leading brands will be interesting, as follows:

	Per cent.	Per cent.
Tungsten	9.99	18.48
Chrome	2.83	2.90
Carbon	0.69	0.78
Phosphorus	0.010	Not determined
Sulphur	0.010	Not determined
Silicon	Trace	Not determined
Manganese	Trace	0.33

Another contains the following:

	Per cent.
Molybdenum	9.65
Chromium	....
Carbon	0.66
Phosphorus	0.016
Silicon	0.046
Manganese	0.22

In one sense, it is chaos. All traditions as to heating are completely reversed, and no one really knows what is the best. One brand is famous for its excellence in one kind of work, another in another kind, no one yet seeming to cover all of the ground.

One thing is certain, the machine business is revolutionized. These tools have crowded ordinary lathes, planers, drills, etc., away beyond their capacity; machine builders are remodeling their machines to meet the new conditions, and many of the users are throwing out their old machinery for the new, or else remodeling and strengthening what they have. There are many records published of the work done by this steel, giving speed per minute, feed, depth of cut, etc., so that it is not necessary to repeat them here. A few illustrations of what can be done may be interesting:

In one case a couple of steel cast bedplates about 4 feet wide and 9 feet long were to be planed. There was nominally ½ inch to come off, but the unevenness of the casting made the cut about 1 inch in places. The surface was hard and gritty from the sand of the mold. Several tools were tried, each one going about ½ inch and then having to be reground. Next, one tool cut about 2 inches without grinding. Finally a tool was tried that had turned up a large, rusty, cast iron pulley without grinding, and it cut clear across the bedplates and was still in good condition for further work. It is clear that the cost per pound of that tool cut no figure.

Another party had a great many castings to thread. With dies made of the very best carbon steel, he could at moderate speed thread from 2,000 to 3,000 pieces without grinding; with dies made of high-speed steel, and with his machine running as fast as he could drive it, he threads from 20,000 to 30,000 pieces without grinding. Another party turns many pieces of hard brasses. He found it difficult to get a tool that would cut them at all until he tried the right high-speed steel, and made a tool that would cut all day without grinding, running his lathes at the highest speed he could get. The same party bores many cast iron cylinders, and with tools made of steel that would not cut his brass he bores eight to ten cylinders without regrinding, and at a speed so great that the cylinders came out too hot to be handled with the naked hand. He tried in his cylinders the steel that cut his brass so well, and it would only bore two to four cylinders without grinding.

Another party drills 2⅜-inch holes 7 inches deep in soft steel forgings, drilling a hole in about three minutes; the same steel will not make a good threading die for the same forgings, and for this he uses another brand. Neither of these steels will make a good lathe tool for turning these forgings, and for this work he uses a third brand.

*Mr. White claims that the process of treating air-hardening steel known as the Taylor White process is the result of a series of tests made with the specific object in view. It had been discovered that overheating sometimes improved an air-hardening tool, but more frequently it was ruined so the tests were made to discover the critical temperatures.—EDITOR.

All of these brands, upon analysis, would come within the limits of the analyses given above. From all of this two things are clear: One is that there has been a marvelous, a revolutionary, advance in the machining of metals; the other is that steel makers have met the demand remarkably.

It is also clear that we do not know yet where we are and there is much to be learned by everybody. The best methods of hardening may not have been found; it seems that for very high speed work it is necessary to fairly melt the point of a tool and quench it in a strong air blast, and then grind to shape. This would not do for threading dies, milling cutters, etc., for the heat would destroy the tools. Such tools are finished from annealed bars; this high speed steel can be annealed as nicely as carbon steel, differing in this respect from air-hardening steel. The finished tools are heated in a lead bath of 1,800 degrees to 2,000 degrees, and are quenched quickly in ordinary tempering oil, which must be kept cool by a coil containing circulating cold water; they are then tempered in a bath of heavy oil heated to about 450 degrees. The tools come out bright and clean and do their work wonderfully well.

The steel maker has the most to learn. He must find out why there is such a great difference in the work the steel will do, when there is so little difference in composition. He must find the composition or mixture that will come nearest to meeting all the requirements. He has at his command now ferromanganese, ferrosilicon, ferrochromium, ferrotungsten, ferromolybdenum, ferrovanadium and ferrotitanium. These alloys are all expensive, except the first two, costing from 60 cents to $12 a pound; therefore the present prices of high-speed steel, which to some people seem to be of the fancy order, are really not excessive.

As far as we know at present, the steel users have not succeeded in making tools that are satisfactory for finishing, and for this purpose they resort to tools of carbon steel, after having done the rougher, heavier work with high-speed steel. This difficulty may be overcome by proper methods of hardening and tempering, or the steel makers may find a composition that will make a tool that is as good for finishing as for roughing.

IMPROVED TOOL STEEL IN RAILWAY SHOPS.

Paper Presented by Mr. W. R. McKeen at the Annual Convention of the American Railway Master Mechanics' Association, at Saratoga Springs, N. Y., June, 1904.

The following tests of tool steels were not made on specially devised castings or forgings, nor were any machines arranged in special reference to these tests. All observations were made on work going through the shop during regular working hours and on actual locomotive parts being put through the shop, these same parts being afterward applied to locomotives. The tests were conducted according to the directions of the chemist and engineer of tests, and under the supervision of the general shop demonstrator; the electrical readings were taken by the local electrician, and the machines were handled in their regular course by the mechanics assigned to each class of work. Turning and planing tools were forged and tempered by the regular toolsmith, and the twist drill and milling cutters were made in the local tool room. Under these conditions a much fairer comparison as to the actual benefits obtained from alloy tool steel in regular shop practice can be made than where special conditions are followed.

Three lines of comparison were taken, namely: First, the speed, cut and feed; second, the durability of tools; third, the amount of power expended in keeping a tool up to its proper capacity. The first depends upon the volume of output; the second on the quality of steel and manufacturer's and toolmaker's skill; the third being closely related to the first and dependent on it. Throughout these tests the new alloy steels were compared with the old carbon variety. In tests 1 to 6 it is well to bear in mind that the air-hardening tools have been in the market for a number of years, and, roughly speaking, are a mean between the carbon steel and the alloy steel.

Tests 1 and 2. Roughing out side rods on planer; channel 1 by 4 inches by 4 feet 6 inches. The time of test indicates the cutting time of tool only, neglecting the reverse of planer, as well as the setting of work. The alloy tool kept its edge throughout the tests and was in condition to do two or three hours more work without regrinding, as shown in equivalent performances at other times. The regrinding was due, not to the cutting edge being destroyed, but to the hollowing out of top of nose of tool by surface friction of the metal removed. The time given as "time of test" was the actual cutting time required to rough out one channel of one side rod. The carbon tool, on the other hand, had its cutting edge completely burnt off at the end of three-quarters of a minute (two strokes of the planer), destroying the nose for half an inch, making any further cutting action impossible. Previous experience with the same kind of carbon tools on this class of work has demonstrated that in order to keep up the cutting edge of a tool (without regrinding, as with alloy steels) only one-half of the depth of cut could be maintained, as was taken in Test 2, removing then only one-half as much metal per hour as shown in that test, and increasing the actual cutting time to about 25 minutes. Comparing the time required by each tool for actual cutting, and for reverse of planer in each case, we find that the alloy steel tool will finish up one rod channel in 7½ minutes and the carbon steel tool in 40 minutes, a difference of over half an hour for each rod turned out. Two rods are ordinarily turned out at the same time; therefore the difference in time is about 16 minutes in favor of the high-speed tool for each channel cut.

Tests 3 and 4. Turning old and badly worn standard driver tires, 70-inch diameter. Table 1 shows that when considering the grinding of tools or interest on plant, the new steels are money-savers. A carbon roughing tool will require 15 minutes (walking to and from emery wheel, etc.), and each tool will ordinarily be reground three times for each tire turned; whereas the high-speed tool will last throughout the job with one grinding. In this table, showing comparative cost of output, it will be seen that there is not a single operation in which the new tools do not directly or indirectly effect a sav-

TABLE I. COMPARATIVE COST OF OUTPUT FOR ONE PAIR OF DRIVING WHEELS.

Operation.	Carbon. Hrs. Min.	Air Hardening. Hrs. Min.	High Speed		Carbon.	Air Hardening.	High Speed.	
			Hrs. Min.	Hrs. Min.				
Setting tool, etc., throughout job	1:30	1	:45	:36	$0.50	$0.33	$0.25	$0.20
Grinding roughing tool	1:30	1	:20	:20	.50	.33	.11	.11
Grinding flanging tool	1:30	1	:04	:04	.50	.33	.02	.02
Roughing cut	8	5	1:15	1:00	2.65	1.65	.41	.33
Finishing cut	5	2:30	:30	:30	1.65	.83	.17	.17
Flanging cut	2:30	1:30	:30	:30	.85	.50	.17	.17
Total labor	20:00	12:00	3:24	3:00	6.65	3.97	1.13	1.00
Interest, depreciation, repairs, etc., figured at 15% on first cost, per hour					.13	.40	.40	....
" " " " " " " " " " " " per job					2.60	1.60	1.30	1.20
Power, at 3 cents per horse-power hour, per hour					.07	.12	.18	..
" " " " " " " " " " " " per job					1.00	1.00	.50	.50
Total fixed charges					3.60	2.60	1.80	1.70
Total of all items					10.25	6.57	2.93	2.70

NOTE.—Since test was compieted the average time and cost of turning drivers has been somewhat lowered, as shown by the second column under "High Speed" in each case.

TABLE II. COMPARATIVE PERFORMANCE OF ALLOY AND CARBON STEEL.

	MACHINE AND EQUIPMENT	METAL MACHINED.	Feed per Revolution. (Inches.)	Depth of Cut. (Inches.)	Speed. (Ft. per min.)	POWER TO RUN MACHINE.						Effective Horse-power for Cutting.		Metal Removed. (Pounds.)		TOOL.					Total Longitudinal Feed. (Inches.)	Time of Test. (Minutes.)	Condition of Tool after Test.	REMARKS.
						LIGHT.			UNDER LOAD.							Size.	Angle.			Kind of Steel.				
						Volt.	Amp.	H. P.	Volt.	Amp.	H. P	H.-P	% of Total.	Per Hour.	Per H. P. Hour.	Height-Width (Inches.)	Top.	Front.	Side.					
1	Planer, 60"x 60"x 30'	Soft steel side rods 4" 8" long cut.	¼	1	16	219	43.8	12.9	219 4	71 1	20 9	8	38	780	97 5	2¼ x 1¼	60°	80°	80°	Alloy	4	44	Very good.	Limit of machine
2	20 horse-power Westinghouse motor		3-16	¼	16	219	43.8	12.9	212	56	15.9	3	19	288	92	2¼ x 1¼	60°	80°	80°	Carbon	¾	¾	Burnt ¼"	
3	Wheel lathe, 100" swing	Old and badly worn Standard driving wheel tires, 70" dia.	3-16	5-16	23	228	12	3.7	226	21.2	6.4	2 7	42	96	36	2¼ x 1¼	82°	78°	98°	Alloy	4	17	Very good.	
4	15 horse-power Westinghouse motor Gear driven.		3-32	3-16	6	226	6	1.8	228	7 6	2 3	5	22	15	30	2 x 1	82°	78°	88°	Carbon	¼	27½	Burnt up.	
5	Pond engine lathe, 42"	Hard cast iron Cylinder.	¼	5-16	22	227	25	7 6	228	38	11 6	4	34	180	45	2 x 1	60°	80°	80°	Alloy	6	8	Good.	
6	20 horse-power Westinghouse motor. Countershaft.	Bushing, 29" dia.	3-16	5-16	11	228	24.5	7 4	228	32.6	10	2 6	26	54	20 7	2 x 1	60°	80°	80°	Carbon	4	14	Burnt up.	
7	Vertical milling machine.	Cast iron locomotive shoe.	00674	.....	45	222	6	1.8	222	15	4.4	2.6	59	195	75	4½" dia.x 3½" face	.....	.....	.....	Alloy	20	6	Very good.	
8	10 horse-power Westinghouse motor.		00275	.....	45	222	6	1.8	219	10.7	3.1	1.3	42	82	63	4½" dia.x 3½" face	.....	.....	.....	Carbon	20	14½	Burnt.	
9	Radial drill.	Medium hard cast iron blocks, 5" deep hole.	012	Mean 23-64	100	230	4.5	1.4	228.6	16.6	5.6	4 2	75	88	21	1 7-16" dia.	.....	.....	.....	Alloy	6	1.50 sec.	Very good.	Limit of machine.
10	3 horse-power Vertical Westinghouse motor.		.007	Mean 23-64	64	230	4 5	1.2	228 3	8.5	2.6	1.4	54	51	36 4	1 7-16" dia.	.....	.....	.....	Carbon	6	2.55 sec.	Burnt	
11	Radial drill.	Soft steel cutter blanks, 4" deep hole	012	Mean 23-64	100	230	4.5	1 4	222.9	16 1	4.7	3.3	70	88	26 7	1 7-16" dia.	.....	.....	.....	Alloy	6	6	Very good.	Limit of machine.
12	3 horse-power Vertical Westinghouse motor.		.007	Mean 23-64	64	230	4	1 2	227	10.9	3.3	2 1	63	51	24 3	1 7-16" dia.	.....	.....	.....	Carbon	2	14½	Burnt ¼"	

ing in setting and grinding tools, varying from 50 per cent. to 98 per cent. of time originally taken with the carbon steels. These savings are real gains and not mere statements on paper.

To take up the table part by part: The first line shows time consumed in setting tools; where these tools have been taken out of the holder frequently for regrinding, etc., more time will be so occupied than when practically no resetting occurs. The grinding shows up clearly the comparative durability of the tools; the old steel requiring much more frequent grinding than the high-speed or alloy steels. While the flanging tool does not have such severe usage as the roughing tool, it requires much greater care in grinding. With the alloy tool one grinding of same will answer for about 15 wheels, or an average of four minutes for each pair of wheels. In the tests the flanging tool was of special design, being quickly ground to standard by tool room; the average time occupied for grinding per each pair of wheels being two minutes.

The next three items—roughing, finishing and flanging cuts—are the main economical features, and are entirely due to the high speed capacity of the new tools. It will be seen that the labor cost in the case of the high speed is only half that with the ordinary air-hardening steel, and less than one-third as much as with the old carbon steel tools.

The interest, depreciation, repairs and renewals to machine and electrical equipment have been estimated at 15 per cent. on $6,000 for the modern lathe, or 40 cents per hour, and at 10 per cent. on $3,000 for an old-style lathe, which would be sufficiently fast for the speed capacity of the old carbon steel tools. It must be remembered, in this connection, that there has as yet been no driving wheel lathe built expressly for high-speed alloy steels. [The author is mistaken in this statement.]

The power (delivered to work) has been taken in all cases at 3 cents per horse power hour, a conservative figure for conditions in the middle West, and considering the many transmission losses.

To summarize these features:

Planer Tests 1 *and* 2:—Alloy steel necessitated 20.9 horse power removing 780 pounds of metal per hour, as against 15.9 horse power with carbon steel and only 288 pounds metal removed per hour.

Wheel Lathe Tests 3 *and* 4:—Alloy steel necessitated 6.4 horse power with 96 pounds metal removed, as against 2.3 horse power with carbon steel and 15 pounds metal removed.

Lathe Tests 5 *and* 6—Cylinder Bushing:—Alloy steel necessitated 11.6 horse power and 180 pounds of metal removed, as against 10 horse power with carbon steel and 54 pounds metal removed.

Milling Machine Tests 7 *and* 8. Locomotive Shoe—Alloy steel necessitated 4.4 horse power and 195 pounds metal removed, as against 3.1 horse power with carbon steel and 82 pounds metal removed.

Radial Drill Tests 9 *and* 10. Cast Iron Blocks:—Alloy steel necessitated 5.6 horse power and 88 pounds metal removed, as against 2.6 horse power with carbon steel and 51 pounds metal removed.

Improved, or alloy tool steel has increased the output of railroad shop machines from 25 per cent. to 100 per cent., and in certain cases as much as 200 per cent., and while, with increased output, the horse power required to turn out work has increased, this increase of horse power absorbed is not in proportion to the increase in output. The use of alloy steel, where machines have been driven by motors already worked up to capacity, will necessitate 25 per cent. to 50 per cent. larger motors, as has been evidenced by our own experience.

The strength and capacity of our present machines are almost universally overtaxed, for the reason that they were not designed for the new conditions. Our experience has shown conclusively the necessity for heavier and more substantial design of all machines; steel pinions instead of cast iron; longer bearings for shafts and increased diameter of same, etc. Furthermore, it clearly demonstrates beyond the credulity of anyone the economy of scrapping old-style machinery.

Our best record on locomotive driving wheels is a 56-inch pair in 1 hour and 27 minutes. Steel-tired car wheels formerly required from 5 hours up to turn and true to size; the present minimum time in our shops is 55 minutes, the average being

about two hours. While these reductions in time are largely due to the alloy steel, improved shop methods and system have also entered considerably into the economies mentioned.

STUDY OF VIBRATIONS OF A LOCOMOTIVE IN ACTION.

La Revue Technique, February 25, 1904, p. 48.

Herr von Borries, professor at the Charlottenburg Technical School, presented a paper to the German Society of Mechanical Engineers on October 13, 1903, in which he showed that the oscillations of locomotives due to the unbalanced weights of the engine, could be reduced to a rotative motion about a vertical axis passing through the center of gravity of the machine and a forward surging motion acting longitudinally. The amplitude of these oscillations can be calculated by rules that the author states very clearly.

In the case of a well-designed locomotive, where the balance of the reciprocating parts is properly proportioned by means of the counterweights, these oscillations are not sufficient to cause a dangerous disturbance of the locomotive. Their amplitude is limited and remains constant regardless of the speed of the engine. The amplitude of the swaying motion of a 4-4-0 high-speed locomotive is not more than 0.16 inch if 20 per cent. of the weight of the reciprocating parts is balanced.

Herr von Borries has designed a very ingenious model, that is described in his paper, by means of which he has shown very clearly that the oscillations due to forward surging and swaying are small and synchronize with those of the driving axle. The amplitude of these vibrations does not vary with the speed, so that from that standpoint there would be no danger in building an engine to run at a speed of 115 miles an hour. The generally accepted opinion, then, that these oscillations increase with the speed is erroneous. From this it appears that the rotation about the vertical axis that occurs in a locomotive as a result of the movement of the reciprocating parts, is confounded with the swaying motion of vehicles upon rails. This swaying motion has a much longer period of oscillation than the rotation of the locomotive. It is brought into being at a certain speed and increases rapidly. In order to differentiate between these two oscillations it is necessary to observe their periods and count the number of turns of the driving wheels at the same time.

When a locomotive is running the stresses due to forward surging must be taken into account. At high speeds they may become dangerous and may reach considerable proportions. In the case of a locomotive where the weight of the reciprocating parts for each cylinder is 660 pounds, of which 20 per cent. is balanced and with driving wheels 7 feet 2½ inches in diameter and the stroke of the piston 23½ inches, the surging movement produced, at speeds of 75, 95 and 115 miles an hour, corresponding to a speed of rotation of 4, 5 and 6 revolutions per second, becomes equivalent to a stress of 10,120; 15,840 and 22,880 pounds respectively. These stresses occur in opposite directions, twice for each revolution of the driving wheels. It must, therefore, be quite evident that these stresses, which are produced so rapidly in opposite directions, must have some influence upon the coupling to the tender. The stresses set up by surging are also not as inoffensive as might be supposed and their complete suppression is one of the principal advantages of the four-cylinder locomotive.

The resultant effects of swaying decrease as the wheel base is increased. The couple producing this motion has a lever arm equal to the spread of the cylinders, and they are resisted by one whose lever arm is the wheel base of the engine or the distance from the center of the bogie to the back axle, when the engine has such a truck. On the other hand, the couple which produces swaying is 70 per cent. of the stress which produces surging. In the case of four-cylinder locomotives and admitting that reciprocating parts of the engines weigh one-third less than in the case of the ordinary engine, the swaying action would be one-eleventh that produced by surging, at a maximum.

This explains why, with locomotives having a long wheelbase, the swaying motion is scarcely perceptible when there are outside cylinders and disappears entirely when they are inside or when there are four. It would seem, then, that recourse must be had to four-cylinder engines for high-speed service, since they are the only ones which do away with the effects of surging and, at the same time, annul those of swaying. From the standpoint of ease of motion and stress upon the roadway the electric motor possesses no advantage over the four-cylinder engine. G. L. F.

* * *

THE NEW WHITE STAR STEAMER BALTIC.

The new White Star steamer, *Baltic*, made the port of New York July 8, completing her first trip across the Atlantic. The building of the *Baltic* has wrested the palm from the *Cedric* and *Celtic* and she is now the one that is notable for being the largest vessel afloat—a statement that implies an immense size in these days of floating leviathans. This great ship, built by Harland & Wolff, Belfast, is 725.9 feet long, 75 feet wide and 49 feet deep and has a cargo capacity of 28,000 tons, or the equivalent of 700 railway cars of 40 tons capacity each. When loaded to her "Plimsoll" mark the *Baltic* displaces 40,740 tons of water, or about 1,420,000 cubic feet.

She has eight decks including the sun deck at the top of the superstructure, which is about 50 feet above the water at full lading. In the hold are the cargo and deep ballast water tanks, forward; coal, engines and boilers, amidships; and deep ballast water tanks and cargo, aft. The lower orlop deck carries cargo forward; coal, amidships; and cargo and meat chambers, aft. The orlop deck has meat chambers and cargo, forward; coal bunkers, amidships; and meat chambers and cargo, aft. The lower deck has meat chambers and cargo forward; crew and coal bunkers, amidships; and third-class passengers, aft. The middle deck carries the second-class staterooms and third-class mess room, amidships; third-class accommodation forward and aft of saloon. On the upper deck the crew is forward; first- and second-class staterooms and first-class saloon, amidships; and third-class smoking room, aft. On the promenade deck are the first-class staterooms, and second-class smoking room and library. On the boat deck are the first-class staterooms, and on the upper or sun deck, are the first-class smoking room and library.

The above somewhat lengthy category gives a meager idea of the immensity of this great vessel which has accommodations for 3,000 passengers and a crew of 350—enough to populate a good-sized town. The vessel has twin screws and the propelling engines are quadruple expansion, balanced on the Schlick system. In power the *Baltic's* engines are far below many of the other modern steamers, being only 13,000 I. H. P. She was not designed for speed, however, but is first of all a freight boat and after that a passenger boat for those who care more for comfort than a swift passage. The immense size of the hull and the provision for water ballast reduce the tendency to roll in a seaway. Besides she has bilge keels or rolling chocks that also materially deaden rolling action. The water ballast tanks in the double-bottom hold 6,500 tons of water so that with a light cargo the displacement may be maintained nearly equal to that with full lading. Powerful pumps are provided for filling or emptying the double-bottom quickly. In general equipment the *Baltic* has all that human ingenuity has been able to provide for safety and economy of operation. A safety indicator for preventing collisions with other vessels is a device never before applied to mercantile vessels, although in use in the British navy.

* * *

A writer in the *Foundry* apparently strains a point in trying to prove that Mr. Outerbridge's discovery, that cast iron can be permanently expanded by repeated heatings up to, say, 1,200 degrees F. (see April MACHINERY), also explains the alleged fact that the flatirons used for ironing "lose their temper" as they become old, that is, do not retain heat as well as new ones. The same condition is alleged to affect curling irons, an old curling iron not heating as quickly as a new one and losing its heat quicker. How much truth there may be in this alleged condition we are unable to say, but it seems scarcely reasonable or consistent that the expansion of cast iron due to the repeated heatings of "ironing day" can permanently expand the molecules of a flatiron to such an extent that the internal circulation of air could account for such a phenomena, as is advanced by the writer.

TOOL MAKING.—9.

HOLLOW MILLS.

E. R. MARKHAM.

In many shops hollow mills are used very extensively, while in others they are entirely unknown. It is a fact that in some shops they are used where other tools would serve the purpose better and at less cost, yet in the face of this they are valuable tools when rightly made, and used on work for which they are adapted. Formerly hollow mills were used much more extensively on screw machine work than at present, but observation has taught me that many of the leading manufacturers of high-grade work consider them an indispensable part of their equipment.

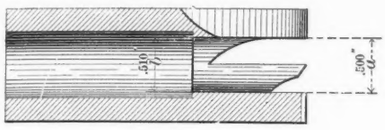


Fig. 1

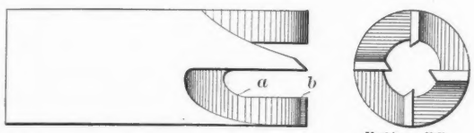


Fig. 2

Hollow mills are usually made from a good grade of tool steel, containing about 1¼ per cent. carbon. Experience has convinced me, however, that best results follow if steel containing a higher percentage is used, provided necessary care is taken when the tool is hardened.

The exact form of the mill and the method of making depend on the use it is to be put to. When used for roughing work, where exactness of size is *not* essential, there is no means provided for adjustment. If the mill is to be used for finishing at a comparatively light cut, and especially where exactness of size is essential, it is made adjustable. If the work to be done allows the use of a mill having inserted blades, and many mills of a size are to be used, this form is found the cheaper. When mills with inserted blades are used, the blades are generally made of high-speed steel, as much higher speeds

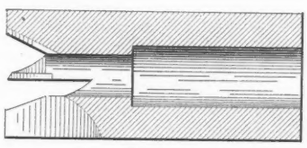


Fig.3

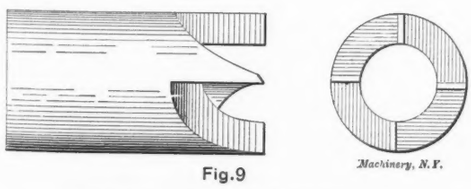


Fig.9

can be used and the tool run much longer between grindings than if the blades were made from the tempering steels. At the present time when high-speed steel can be obtained in all the ordinary sizes and shapes in an annealed state, it is advisable to make not only the blades of *inserted bladed* mills, but also roughing hollow mills, which are made in solid form, of this high-speed steel. Its first apparently high cost is more than offset by the amount saved by its use.

Hollow mills must be given clearance, so that they may not bind when in use. This is accomplished by several methods. One of the more common methods consists in making the hole tapering, having it smallest at the cutting end. Fig. 1 shows a hollow mill whose hole is enough larger at the portion marked *b* than at *a* to prevent "hugging" of the work, thus roughing it or twisting it off.

In the case of small mills, the hole is tapered by means of a taper reamer; those having larger holes may be given taper by boring in the lathe or by grinding with an internal grinder after the tool is hardened. For many purposes it is considered advisable to make the hole straight, and give the necessary relief by working off the lands, as shown at *a*, Fig. 2. The relief is carried to face *b*, but none of the stock at this point should be removed. If the hole in the mill is sufficiently large the greater portion of this stock may be removed by means of an end mill, and the work finished by filing, but if the hole is not large enough to allow of this, the stock is removed by filing. When the hole is made tapering, as described under the first method, and the taper is produced by reaming or boring, this must be done before cutting the teeth. If relief is given as shown in Fig. 2, it is, of course, necessary to form the teeth before giving relief.

Roughing Hollow Mills.—Roughing mills are used for removing the bulk of the stock, leaving a sufficient amount for the finish mill or box tool. In order that they may start on the stock easily, this form of mill is often made as in Fig. 3. Roughing mills are usually made solid, that is, with no means of adjustment. The teeth are made stronger than those on finish mills, which are generally made adjustable.

Adjustable Mills.—This form of mill has its teeth cut deeper than a solid mill; that is, they are longer and slenderer, to allow them to spring for the desired adjustment. The adjustment is obtained by means of a clamp collar of the form shown in Fig. 4; or a collar may be used having a setscrew

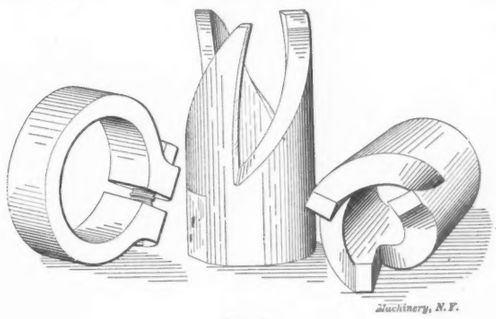


Fig 4.

to adjust each jaw, as in Fig. 5. Some mechanics consider it best practice to get the desired adjustment by means of a collar having a tapered hole which fits on a tapered portion at the end of the mill, as shown in Fig. 6. When it is necessary to close the mill, the collar is driven further onto the tapered portion. The advantage claimed for this form of adjusting collar is that the teeth are all closed uniformly, thus insuring a uniform cut on all the teeth.

When the mill is too small to allow of grinding the hole to size after it is hardened, it must be given the desired clearance with a taper reamer, reaming from the back end so that the hole may be smallest at the cutting end. The amount of taper should not be great; a small amount provides sufficient clearance to prevent binding and permits of more grinding before the mill is too large to allow of the adjustment necessary to bring it to the desired size. The Stubbs broaches formerly used so extensively in machine shop work seemed to provide about the proper clearance.

As previously stated, when cutting the teeth of adjustable mills, they must be cut deeper, longer and slenderer than for solid mills, so that they may be sprung together to provide means of adjustment for size. They should not, however, be so slender as to chatter when in use, and should be strong enough at the base of the tooth to prevent the tooth springing in the direction of the pressure applied when cutting. The form of tooth provided this class of tool varies in different shops. In some the tooth is of the form shown in Fig. 7, while in others it is thought best to make it as in Fig. 8, provision for adjustment being made by means of saw cuts as shown.

When roughing mills are to be used in screw machines for roughing down square or other forms of irregular stock, as well as round stock, it is well to bevel the teeth at the cutting end in the form of a V, as shown in Fig. 3, so that the tool may center itself when starting to cut. If the shoulder at the end of the cut must be square it is necessary to follow the cut made with this mill by the tool whose end is of the form shown in Fig. 9.

Roughing mills do not require as many teeth as those used for finishing; the fewer, the better, provided there are enough to properly support the work, as this leaves more room for chips, and chips are the most troublesome thing the mechanic has to contend with in the ordinary processes of machining with tools whose cutting edges are formed of a number of teeth. The teeth of roughing mills should be short and stubbed, to provide strength. Ordinarily they are four in number, although for certain work three has been found preferable; and for some classes of work mills having but one tooth have been found to work nicely when those having more could not be made to work at all. Such mills, however, seldom work well except when run through a bushing, which, of course, guides and supports it when working.

The writer was connected for a number of years with a company who manufactured calipers, dividers and other machinists' tools. We had occasion to cut a circular groove at opposite sides of the caliper nut, and a ring was put in each of these grooves after the nut was sawed in two, thus making a quick-adjusting nut. The nut was placed in the jig and the groove cut with a hollow mill. We found that a mill with two or three teeth would not work, as the chips soon clogged the mill and caused it to break when pressure was applied to make it cut. When given only one tooth the mill worked nicely.

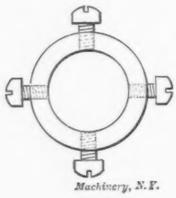


Fig. 5.

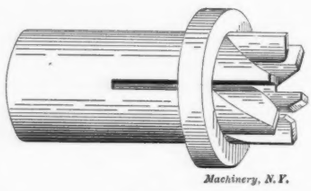


Fig. 6.

When roughing mills are used on round stock three teeth work very well; if square stock is being cut a mill having four teeth will work more satisfactorily, as the opposite corners will be supported at the same time.

Hollow Mills With Pilots.—It is oftentimes desired to machine a projection true with a hole, as indicated in Fig. 10. This may be accomplished by using a mill having a pilot, as shown. As mills of this character are rarely used on small work it is generally feasible to grind the walls of the hole to size, and with the necessary clearance, after they are hardened. When possible make the hole to receive the pilot large enough so it may be ground at the same time, to insure concentricity. Fig. 11 illustrates a mill having a hole of this character, the pilot being made with two sizes to accomplish the desired result.

Unless quite a number of tools of a kind are made in a shop it is not thought advisable to make special fixtures and holders for doing the work. As a consequence the operator is called upon to improvise something that will accomplish the desired result, and yet do away with the cost of the special tools required when work is done in quantities. The man who can devise ways and methods of producing accurate work, where the necessary machines and tools are not available, and can do it satisfactorily, without materially increasing the cost, is the valuable man. Now we all know that the only means provided for holding work of the character under consideration in the ordinary universal grinder is a three or four-jawed chuck. If the chuck is universal jawed it is in all probability not true; and if it is an independent-jawed chuck it is almost impossible to true the piece of work to run as we wish it to. While this may be accomplished very nicely on the lathe, where we can detect any error by means of an indicator, the circumstances are so entirely different with the grinder that it becomes a very difficult task. However, we may get the work to run true by holding the back end in a collar held in the chuck. This collar should have a hole a few thousandths of an inch smaller than the end of the piece we wish to grind. After securing the collar in the chuck, the hole may be ground to a size that allows of wringing the work into it sufficiently tight to hold it while grinding. If the piece of work be long the outer end may be supported in the *back* or *center* rest.

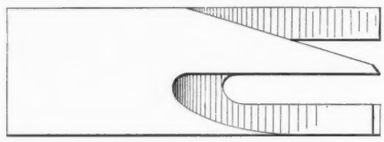


Fig 7

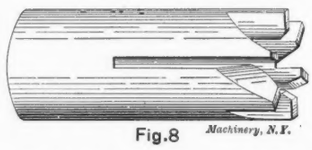


Fig.8

Hollow Mill in Place of Counterbore.—Very often it is necessary to enlarge a hole to a degree that makes it a costly operation when a counterbore is used. A hollow mill having a pilot will be found to furnish an easier and a cheaper method of accomplishing this. It is, however, open to the objection that the portion removed has a decided tendency to stick in the mill, thus causing a great deal of trouble. This is overcome by making the interior portion eccentric to the outside; in other words, by having the wall thicker at one side than at the other. The pilot must, of course, be concentric with the *outside*.

If the mill is to be guided by a bushing no pilot is needed. Fig. 12 shows a hollow mill designed for use as described above, while Fig. 13 shows a piece of work for which such a tool is specially adapted.

When the hole to receive the pilot has been made and the body and pilot have been turned and finished to size the large hole in Fig. 12 is bored to desired size. This is accomplished by placing the mill in an independent jaw chuck, moving the jaws until the mill is located to give the desired amount of eccentricity, which for a mill of 1½-inch diameter may be 1-100 to 1-64 inch. This amount may be varied for different sizes of mills.

If the stock to be cut is thick the mill should have fewer teeth than when it is used on thin stock. The exact number cannot be stated arbitrarily, but must be governed by conditions under which it is to be used. If possible, the teeth

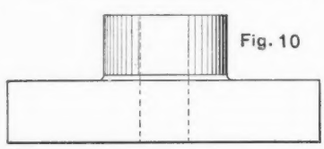


Fig. 10

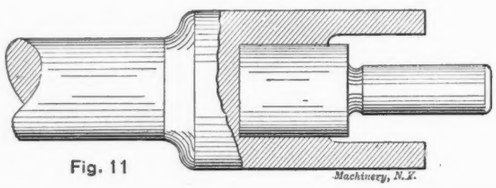


Fig. 11

should have space enough between them to hold the chips removed; otherwise it will be necessary to withdraw the tool from the cut and remove the chips to prevent the teeth from breaking. A common fault with certain classes of cutting tools is teeth that are too fine, or in other words insufficient space between teeth.

Hollow Mills With Inserted Blades.—This form of hollow mill is of especial value when the tool is large, or when it is to be used on hard stock or on material covered with a

hard scale. The blades being removable are easily sharpened when dull, or can be replaced at slight expense when worn out, thus saving the expense of a new tool. Then again the blades may be made of high-speed steel, as stated in the fore part of this article, which makes it possible to cut hard stock, or to run at a high rate of speed when machining.

As a rule high-speed steel, even when purchased in bars of the right size and shape, does not give as good results if used in the condition in which it is bought as when properly hardened before using. If it is found necessary to machine this

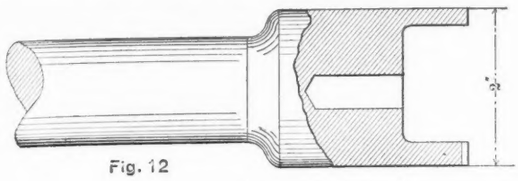


Fig. 12

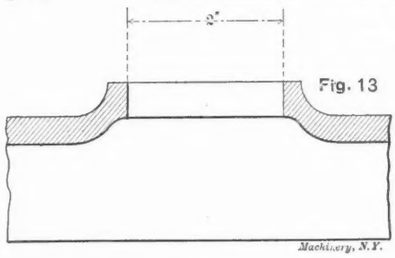


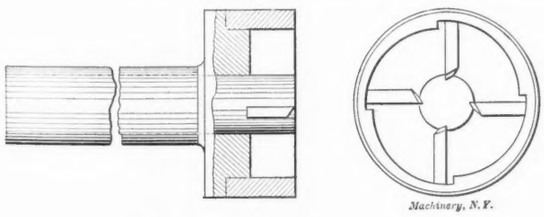
Fig. 13

Machinery, N.Y.

steel to size, by means of cutting tools, it can be annealed to work very nicely by packing in a tube, or an annealing box, with a quantity of dry fireclay and subjecting to a full red or a yellow heat for a number of hours, then allowing it to cool very slowly, as described in a former article on "High Speed Steel."

After annealing it may be machined with tools used for machining other kinds of steel, but best results follow the use of tools made from high-speed steel.

Most makes of this steel need a very high heat when hardened. The exact amount I have found to vary for different steels; most of them require what is familiarly termed a white heat, although one make that I have used with excellent results hardens at a red heat. However, as instructions are furnished with the steel there need be no experimenting as to the proper heat for the individual steel. When it has been given the proper heat it may be hardened in an air blast, or in oil, the latter being generally used for tools where size must be retained or where a poor surface would not be desirable. When heating for hardening it is generally necessary to use a method that will prevent scaling the surface. A good way is to heat in a crucible of melted lead, heated to the desired temperature. Heat the steel first in a fire, or in another kettle of lead which is not heated above a low red; for if the steel were plunged in lead which is heated to a white, while it is cold, it would expand so rapidly at the surface as to cause it to crack. It is therefore apparent that it must be heated gradually until it is plastic, when it is safe to plunge it into the lead at the high heat.



Machinery, N.Y.

Fig. 14.

A more satisfactory method of heating this kind of steel consists of a form of gas furnace especially designed for this class of work. In this furnace the steel can be given any amount of heat, and the surface will be free from scale, as it is removed from the action of the air while heating in the furnace, and consequently the surface cannot oxidize.

There are many styles of inserted blade hollow mills, a few of which we will consider. As in the case of all tools used in the machine shop, the design of a form of mill must be selected whose first cost is not out of proportion to the amount saved by its use. It is not always good policy to make a form of tool whose first cost is in excess of another, even if the cost of machining each piece would be materially reduced thereby. This is especially true where the number of pieces to be machined is small. In other words, it is not generally considered advisable to make the more costly form of tool unless the cost of the tool plus the cost of machining is no greater than the cost of the cheaper tool plus the cost of the work it does. Where great numbers of pieces of work are done and the same operations are repeated for an indefinite period a design of tool is generally adopted which will produce the work in a satisfactory manner at the least cost, with no special regard to the first cost of the tool. By this I do not intend to convey the idea that the cost of tools should not be considered; on the contrary, I believe a strict account should be kept of the cost of every tool and that the probable cost and the amount to be saved by its use should also be considered before deciding to make it.

A form of hollow mill made in some shops where mills with inserted blades are used is shown in Fig. 14. The blades being in slots, the outer ends of which bear against the inclines in the rings, can be readily adjusted to size. This form of mill is rather expensive and as a result is seldom made unless a tool of this character is to be used almost constantly. The operations of making are very similar to those for the self-opening die described in a previous article.

Another form of hollow mill having inserted blades is shown in Figs. 15 and 16. Fig. 15 is a roughing mill and a form used for finishing surfaces. This mill can be made more cheaply than the form shown in Fig. 14, but is open to the objection that it cannot be set to size and alignment so easily.

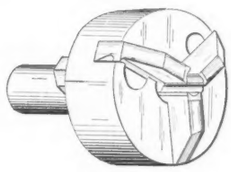


Fig.15

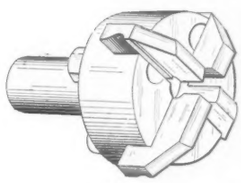


Fig.16

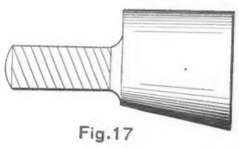


Fig.17

Machinery, N.Y.

Blades for machining various sizes of work may be made for this mill, so that it can be used for quite a range of sizes of work. As stated in the case of the mill previously described, high-speed steel may be used for the blades, thus making it possible to run at high rates of speed.

The holder is made from machinery steel, the shank fitting the holes in the turret of the machine in which it is to be used. The slots for the blades are cut to the proper width and depth, and with the edge corresponding to the cutting edge of blade, radial—on line of center.

The blade has a bevel cut on one side. A stud having a corresponding bevel on one side, as shown in Fig. 17, is used as a binder, and binding is accomplished by drawing the binding stud down on to the bevel of blade by means of a nut on the back of the body—or head—as shown. The roughing mill is ordinarily given three cutting edges as represented in the cut. The finishing mill differs from the roughing mill in that it has two blades and two back rests, the latter steadying the work while the blades are cutting.

When a hollow mill is wanted which can be made more cheaply, the design shown in Fig. 18 may answer the purpose, although it cannot be set as accurately as the form shown in Fig. 14, especially as to alignment.

This style of mill is used on large work. The slots should be milled with a cutter whose thickness corresponds with the

corresponding dimension of the steel to be used for the blades. If the stock to be milled is hard or in any way difficult to machine, or if it is desired to machine it at a high speed, use high-speed steel in the construction of the blades. The slots to receive the blades should be cut somewhat deeper at the front end in order to provide clearance; this also allows of a slight adjustment in size, as the blades if moved ahead in the slots will cut a trifle smaller. Two collars of machinery steel should be provided, to hold the blades in place. The holes in these collars must be of a size that allows them to readily slip over the blades when in position in the slots. Each collar must be provided with the same number of set-screws as there are blades in the hollow mill, as there must

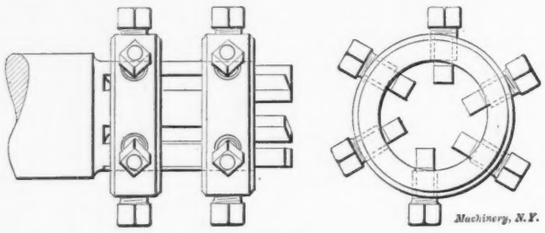


Fig. 18.

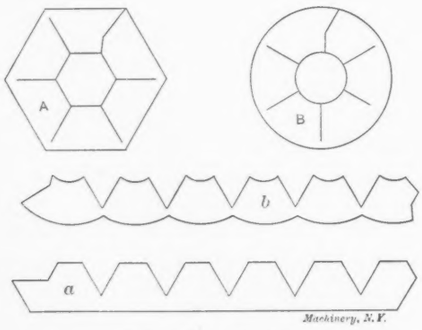
be a setscrew bearing on the blade at each end. The collar placed nearest the shank of the mill holds the blades securely in the body; the other is placed near the cutting edges, as shown, to support them while cutting. The length of surface cut with a mill of this character is somewhat limited; the cut can be no longer than the distance the blades project beyond the holder.

As stated, this mill can be adjusted by moving the blades back and forth in the slots. The amount of adjustment can be still further increased by placing thin strips of metal, or even paper, in the bottoms of the slots beneath the blades. When milling the slots for the blades it must be borne in mind that the edge of the slot corresponding to the cutting edge of the blade must be radial.

* * *

HOLLOW BLOOM TUBE-MAKING IN ENGLAND.

The process of hollow bloom tube-making, the invention of Mr. George Inshaw, is described in a recent consular report by Consul Halstead at Birmingham, England. The inventor's object is to produce a seamless iron or steel tube for steam, gas, or water, and all other services, and other hollow articles such as shafting, all to be of a better quality and produced at less cost than when made from strip; of a better quality than when spun over a mandrel; equal to any tubes made from a pierced or bored bloom; and perhaps, owing to the amount of work the metal received in the rolling, of as good a quality as when cold drawn.



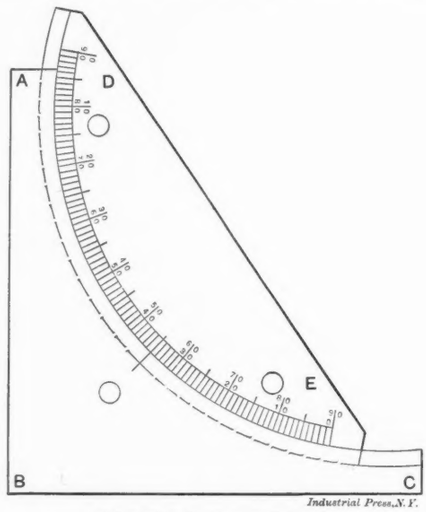
Hollow Bloom Making.

Puddled iron balls are first formed into slabs by means of a steam hammer, and these slabs are then rolled into blocks or bars, with longitudinal segmental projections connected with a thin backing or plate of metal, a cross section of which is shown in the accompanying cut, as are cross sections of the two kinds of hollow blooms, which may be formed by the rolling of either of the two forms of segmental projections on the bars. In one kind the interior of the bloom is round, as also is the exterior; in the other the interior is hexagonal and the outside approximately the same shape. The plates or bars, without reheating, are rolled or formed by being passed through a skelping machine, which bends the thin backing or belt of metal, bringing the longitudinal segmental projections together, thus forming long hollow blooms. These long hollow blooms are sawed into required lengths, and, while still retaining much heat which is not exhausted in the first process—the interior of such a roll naturally retaining heat—are put into a furnace and the heat is raised to a welding point; then they are passed through welding rolls, and, without further heating, made into tubes. The advantage in welded rolled blooms over built-up hollow blooms, would seem to be in the fact that there is less surface for oxidation, and, contrary to the prediction of experts regarding the Inshaw bloom, the angles of the rolls when pressed together seem to push out any oxidized particles into the hollow of the bloom when the inside hexagonal type is used. The rolled bars and corresponding shaped blooms are indicated at *A a* and *B b* respectively.

* * *

ADJUSTABLE PROTRACTOR TRIANGLE.

The cut shows what should be a handy instrument for the draftsman, being a white celluloid triangle having the angles of one side adjustable. The instrument consists of the right-angled part *ABC* and the segmental part *DE*. The circular edge of *DE* is formed with a tongue which fits into a corresponding groove in *ABC*. The edge of *DE* is graduated into



Adjustable Protractor Triangle

degrees so that the outer side may be set to any angle from 0 to 90 degrees with the base. The diameter of the protractor circle is 7 inches and the sides *AB* and *BC* are each about 4¼ inches long. The segmental part slides easily within the other, but the friction is ample to prevent sliding when the pressure of the pen or pencil is applied to the drawing edge. The protractor triangle is the design of Prof. D. A. Low, and is being placed on the market by Longmans, Green & Co.

* * *

An objectionable feature of many dynamos is the humming noise that accompanies their operation. This trouble is found to a considerable extent only with machines having laminated poles and a small number of slots per pole, say, six to nine, and it generally increases as the air-gap between the armature and the poles is narrowed. A German investigator has determined by the use of tuning-forks of known frequencies that the number of vibrations in a second, denoting the pitch, agree in every case with the number of armature teeth passing a given point in a second. It may, therefore, be inferred that the sound is produced by the variations of magnetic flux in the teeth. The investigator has deduced a formula for the relative proportions of pole shoes, width of air-gap, number of slots, etc., which, if followed, has been found to decrease the humming to a minimum or to stop it entirely.

THE MAKING OF SOUVENIR SPOONS.

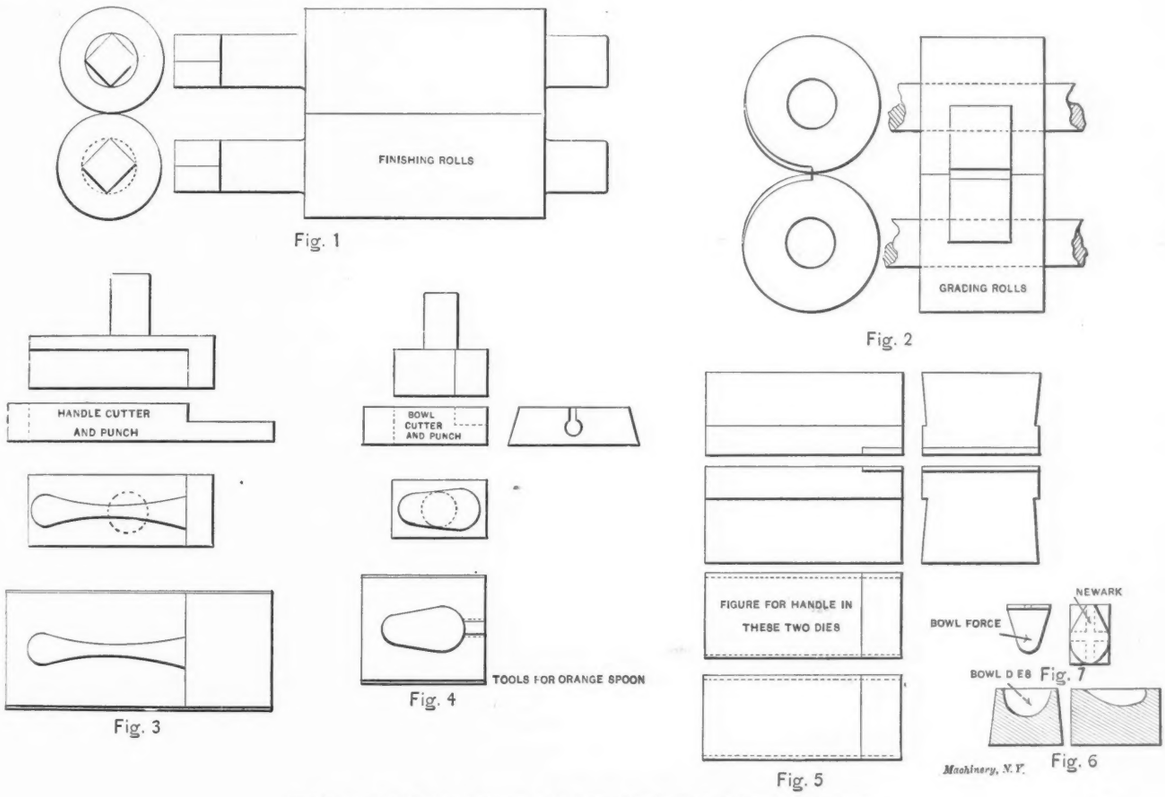
ALEUS.

How many people as they stop and gaze in a jeweler's display windows and see trays of souvenir spoons with the name of the city or town, or the outline of some prominent building stamped in the bowl or the handle, ever stop to think of the number of operations and the amount of labor required to complete one of these spoons for market?

The majority of these spoons are made of sterling silver, which is purchased from an assayer in an ingot at a certain price per pennyweight. The silver is melted in crucibles and the furnaces are usually gas burning, as the heat has to be great. As the silver melts, a small handful of charcoal is sprinkled over the silver in the crucible; this clears all sediment and draws it all to the surface. When the silver is melted, it is poured into a mold which varies in size, the most common being 3 inches wide, ¾ inch thick and 12 inches long. This mold is polished and free from all blowholes and small pits that usually appear in cast iron, of which this mold is made. The mold is always made on a slight taper with a false piece of steel fitted at the bottom; this is used in loosening the ingot by driving on the wedge or false piece. The mold is usually heated and swabbed with a piece of oily waste to prevent the metal from adhering. After the silver has cooled in the mold to a certain degree, it is removed and, if found to be free from pits and air-holes, it is scrubbed with hot water, soap and a stiff brush to remove all substance adhering to the ingot.

The next operation consists of breaking down, which is taking the ingot of silver after it has been scrubbed and rolling it through rolls made of tool-steel, hardened, ground and polished. These are usually 6 inches diameter with a 10-inch face, the size being generally determined by the size of the ingot to be rolled. The silver passing and repassing through these rolls becomes thinner and greater in width at each consecutive rolling, and the rollings are continued until the silver begins to crack on the edges. The operator then knows that the metal has become so brittle that it must be annealed before any more rolling can be done. The ingot of silver is now about ⅜ inch thick, 5 inches wide and 20 inches long. The operation of annealing consists of grasping one end of the silver with tongs and passing it back and forth through a gas furnace until it is red-hot; it is then allowed to cool. After cooling, it is placed in an acid bath, which removes all the oxide and discoloring caused by heating. After the acid bath it is plunged in another bath of boiling water and scrubbed to remove all traces of the acid to protect the rolls from being disfigured by same. The silver is dried by covering with hot sawdust and is then put through the same operation of rolling again, the annealing process taking place as often as the silver requires it, which is determined by the silver cracking on the edges as mentioned before.

Great care must be taken during the operation of rolling to have the rolls exactly parallel with each other; if the rolls are not parallel the stock will curl and not roll straight, thereby stretching the silver more at one side than at the opposite, which causes it to break. Fig. 1 shows the shape of the rolls used. These rolls have to be ground and polished from time to time as they wear irregular and, therefore, do not roll the silver perfect. Again at times an imperfection appears on the surface of the rolls which must be removed as it will always show on the silver.



Tools used in Making Spoons, with Special Reference to Souvenir Spoons.

After the silver has been rolled to its desired thickness, it is then annealed for the last time, pickled and dried, then taken to the finishing rolls, which are made the same as the breaking down rolls, but smaller in diameter and ground more accurately and polished to a better finish. These rolls do no heavy rolling, but are used simply as sizers to bring the silver uniform in thickness. After passing through the finishing rolls, the silver, which is now in a rolled sheet varying in thickness from 0.025 to 0.035 inch, is taken to a pair of rotary slitting shears where the rough edges are trimmed and the roll of silver stripped into desired widths. The rolls of silver, together with the scrap that comes from the shears and that which remains in the crucible after melting (called the "button") are taken to the office and weighed to determine the shrinkage and waste. The silver is now ready to make into spoons.

The silver being in rolls it is taken to the shears and cut into pieces the desired length which vary according to the size of the spoon. The next operation consists of what is termed "grading," which is tapering the ends of the pieces of the silver for the handle and bowl. The pieces of silver are always

cut shorter than the spoon itself as the "grading" operation lengthens the piece. The operation of grading is accomplished by the rolls shown in Fig. 2. These rolls are cut away in the center about ⅛ inch deep at one side and gradually lessening until the cut rises to the face of the roll. This section of the roll is usually about 2 or 3 inches wide, the length being about one-quarter the circumference of the roll. The rolls always run in the direction of the taper, or, in other words, the rolls revolve, so that at one given point the deepest portions of the recesses meet, having at this point a combined depth in the two rolls of ¼ inch. It is at this point that the spoon is inserted for grading. As the handle and bowl are differently graded, there are two of these recesses in each roll. The pieces of silver are taken between pliers, the jaws of these being of a length to determine the length to which the silver is to be placed in the rolls. When the rolls have come to the point where the recess space is greatest, the operator is ready with the blank adjusted in the pliers. He pushes the projecting portion of the blank in the opening until the pliers come in contact with the rolls. In this position he holds the blank until the rolls grasp it and reduce the taper. The rolls are mounted in housings and are adjustable to any thickness.

Having graded both ends of the blank, it is then blanked out in a die made as shown in Fig. 3, which cuts the form or outline of the handle, leaving the bowl end in the state it left the grading rolls. I will explain the object of performing this operation in this manner. Generally a shop manufacturing spoons of this nature has various designs of handles, also it has a line of bowl dies of various sizes and designs. A mixed order is received in which so many spoons of the order are to have a certain handle and bowl, and a certain number to have another design of handle and bowl. By making the dies as shown, any style of handle can be made on any bowl or fancy spoon. Having blanked the handle, another die, Fig. 4, is used to blank the bowl. The blanks are now ready to have the design stamped on the handles.

This work is done in a drop-hammer between the dies shown in Fig. 5. In the dies is cut the design that is required on the top and bottom of the handle. These dies are called matched dies. The depth of the design always determines the thickness of the silver to be used—the greater depth, the thicker the stock. The blanks then pass through the operation of trimming which consists of being forced through dies similar to Figs. 3 and 4, but instead of the punch being flat, the center is cut away leaving a knife-edge on the outside. This is done to relieve the punch, so it will not disfigure the design, and at the same time allow it to cut a clean edge. Having trimmed the handle and bowl, the next operation consists of bowling, or, in other words, to bend the bowl from the flat to the desired shape.

This work is also done in a drop-hammer with the dies, Fig. 6, and the force, Fig. 7. The die is placed between the poppet on the drop-hammer bed and the force is secured in the jack-die, which is fastened to the hammer. The operator now places a blank on the face of the die, releases the hammer, which descends and the force presses the spoon bowl into the die. An automatic drop-hammer is the best for this operation, as it strikes every blow with the same force. If the name of any city or town or the outline of any particular object is desired in the bowl of the spoon, it is cut in the force as shown in Fig. 7. Doing this brings two operations into one, for, as the bowl is formed, the design appears.

The spoons are now passed on to the bench, where the filing is done. This operation consists of filing off the burrs and ragged edges on the bowl. The spoons then go back to the press department, where the handles are curved by being pressed between two hardwood blocks formed to the shape desired on the handle. The spoons then pass into the polishing room to be "boled"; this work is done on an ordinary polishing head, using a cloth wheel with a coating of rotten-stone, which has to be renewed at intervals. The boling removes all sharp edges and scratches on the silver, after which the spoons are polished by using another cloth wheel coated with crocus.

The spoons are then sent to the coloring room for the next operation, which consists of plating the bowls with gold in an electro-plating bath. Some bowls are oxidized; others pass through the operation of sand-blasting, which gives the spoon a dull finish. The spoons that are gold-plated are sent back to the polishing room and again polished, after which they are washed in a solution of hot water and ammonia to remove all stains, and finally they are dried in hot sawdust, when they are ready for the shipping room.

The souvenir spoon industry is very large, one firm alone having over 1,000 designs for bowls, which include the names of every city in United States and Canada of any size, and a large number of cities in other countries.

* * *

A MACHINIST'S DEN.

We presume that many of our machinist friends, who believe in the principle of "self-help," have their own ideas and ambitions for a study and drawing room at home, and that, consequently, they will naturally be interested in what some one else has done. For this reason we reproduce the photograph of the den of Mr. C. W. Putnam, Holyoke, Mass., one of our frequent contributors. The principle article of furniture is the roll-top desk. The desk is conveniently arranged so that it may be used as the support for a drawing-board, or can be quickly cleared away for writing. In his letter describing the den, Mr. Putnam says:

"When I use the desk for drawing, my board is resting on the two slides at the sides as shown, and is tilted in about the right angle for convenience; my drawing tools are kept on the

Mr. C. W. Putnam in his "Den"

right-hand slide. In the foreground you will notice a perspective drawing board I designed, showing a corner of a carpenter shop with work bench. [This cannot be distinguished in the cut.] This bench was drawn by the use of the pins located near the end of the rods, using a rule to guide the pencil; these pins represent the vanishing points, and their location can be arranged on or off the board as desired, as the rods are held to the board by a swivel clamp.

"On the desk will be noticed a card index that I use as a catalogue in connection with my letter files, books, mechanical papers, etc. By referring to this card index I can locate in a minute any letter in the files, or any drawing or manuscript that has been prepared. These I keep in the filing cases on top of desk and in the drawers; also on file clip at the right hanging on a hook. At the left in the corner I keep my mechanical books which are also catalogued.

"For the benefit of non-contributors, I will state that all this shown in the picture was purchased with money obtained in return for my articles published in MACHINERY and other mechanical papers."

LETTERS UPON PRACTICAL SUBJECTS.

A MANUFACTURER'S VIEW OF MAKING SMALL COIL SPRINGS.

Editor MACHINERY:

I read with interest the article in the June number of MACHINERY entitled "An Experience in Making Coil Springs." My interest would have been even greater if the time used in making the 60,000 springs and the cost of the tools for producing them had been stated.

The trouble Mr. Beverts had in making these springs is nothing unusual, and his methods of solving the difficulties he met with are very ingenious, but it only emphasizes again the old adage, "every man to his trade." I venture to say that any good spring maker could have produced these springs cheaper and Mr. Beverts would have escaped all the annoyance and toolmaking and would also have had better springs.

In these days of specialization it is unwise for any one without the proper modern equipment to attempt to make springs, or indeed any small parts that can be bought of specialists in that line. Any modern spring maker is equipped to make the spring in question, with ends drawn in and flattened to give a good bearing surface, at almost no extra expense for tools. The cost of the special tools made in this case would have represented a good profit to the manufacturer on the job.

F. E. WHITTLESEY.

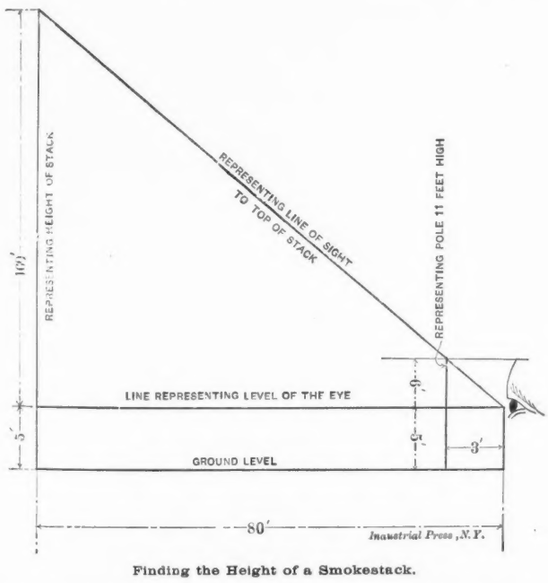
Corry, Pa.

FINDING THE HEIGHT OF A SMOKESTACK.

Editor MACHINERY:

Referring to the article "Finding the Height of a Smokestack from its Shadow," in the June issue, this suggested the query, "What if there was no shadow on the day the Chief Draftsman was ordered to get the height of stack?"

The proper thing to do then would be to take a pole about 11 feet long, and with an assistant to hold it in position while the "Chief Draftsman" would sight over the top of the pole to the top of the stack, either by sighting from the ground or by standing erect, the triangle between the pole and the level of his eye can easily be determined. Knowing the height to



Finding the Height of a Smokestack.

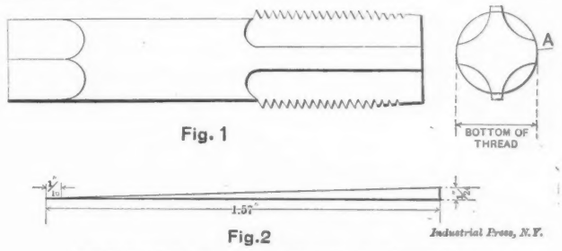
his eye from the ground, and the distance from his eye to the pole, it becomes a very simple problem in mathematics; in short, if the "Chief Draftsman's" eye was 5 feet from the ground, and the 11-foot pole was 3 feet from him, the triangle formed would show a 6-foot side above the level of his eye. Hence, if a man located 3 feet from and sighting over an 11 foot pole (with eyes 5 feet from the ground) projects the side of a triangle 6 feet high, a man whose eye was on the ground would project a side 22 feet high, and as the "Chief Draftsman" stands 80 feet from the stack, which is equivalent to a base of a triangle, it would require a pole or stack 160 feet high (plus 5 feet) to project a base 80 feet long as the same proportion.

Williamsport, Pa. A. P. SHARP.

TAPPING A LEFT-HAND NUT WITH A RIGHT-HAND TAP.

Editor MACHINERY:

I noticed in the November, 1903, issue of MACHINERY a method of cutting a left-hand screw thread by using a right-hand tap in holder, and have been waiting for somebody who had more time than myself to suggest the solution to the question there propounded of tapping out a left-hand nut with a right-hand tap.



Right-hand Tap Ground for Tapping Left-hand Nuts.

Some years ago while foreman of a good-sized machine shop, a job came up where it was necessary to cut right and left threads in opposite ends of a cylindrical drum. At the time we had just increased the drafting force by engaging an assistant who was to brace up especially the designing end of the business. This young man, being asked some questions in regard to the right and left taps that were to be made for the above-mentioned job, said "Why, what is the use of making a left-hand tap? Why don't you turn the tap right around on the other end and tap the left-hand threads?" There was something a little broader than a smile went over the faces of the hearers at this proposition, and to let the young man out of his delicate position one of the men, who had learned his trade at a gunsmith's, said he had tapped out many a left-hand nut with a right-hand tap and to prove his statement produced a very good looking left-hand nut which he said was finished with a right-hand tap. This set the boys thinking and one of them finally produced a very good left-hand threaded hole by using a right-hand tap.

I think the tap used was a special size ½ inch diameter by 24 pitch, right-hand with four flutes. Two opposite lands were ground down to the bottom diameter of thread as shown in Fig. 1 at *A* to support the tap while cutting through the hole. The other two lands were ground down on the sides of the teeth leaving the lands about 1-16 inch wide, as the narrower the lands are made the less resistance will the tool make during the cut.

The piece that was experimented upon was a plate strapped to the cross-slide of an elevating tool-post rest and the tap made as shown in Fig. 1 was held rigidly in a drill chuck in the live spindle. The hole in plate was then lined up opposite tap and the lathe set up to cut the same pitch thread as that of the tap. The lathe spindle was now revolved backward with forward carriage feed and the tap run through hole.

The distance that the thread groove would be crowded over making it larger than if a regular left-hand tap were used is less in actual practice than the figures call for, owing probably to spring both of stock to be cut and also of the teeth of tap. The amount which would be given by the actual figures of the lead on the ½ inch by 24 pitch would be by similar triangles (See Fig. 2), as follows: $\frac{1}{2} \times \pi = 1.57$, and by proportion $1\ 57 : \frac{1}{24} = \frac{1}{16} : x = \frac{0.0026}{1\ 57} = 0.0016 +$, which, multiplied by 2, gives the difference between the lead for right and left-hand threads as 0.0032 inch.

HEXAMETER.

There is a more important reason for grinding away the teeth on two opposite sides of a four-fluted tap than that given by the correspondent. When the thread is changed from right to left the paths of the threads cross each other once in each half revolution so that the teeth of a right- and left-hand tap coincide as to position when on opposite sides. This being the case it follows that the lines of teeth 90 degrees in either direction will be found in paths midway between the paths of those teeth considered above and would cut a thread

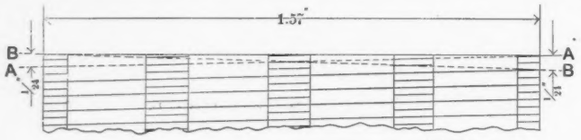


Fig. 3.

midway between that cut by the first. If anything was produced it would be a double thread of the same pitch, but the probability is that in as fine a pitch as 24 the threads would strip away owing to the pressure of the wrongly inclined sides of the teeth in the tap. Fig. 3 shows an enlarged developed surface and illustrates the matter quite clearly, *A A* being path of teeth in a right-hand and *B B* the corresponding path in a left-hand tap. J. A. W.

TOOLS AND JIGS FOR MACHINING AUTOMOBILE SIDE BEARING.

Editor MACHINERY:

I send you a blueprint of an automobile side bearing and sketches of tools and jigs for machining same. The side bearing is a steel casting, and the tools were designed to handle an exceptionally bad lot of castings, no two being alike. It was finally decided that the 41-64 inch and 49-64 inch holes should be drilled in the center of their respective lugs and all the subsequent measurements should be taken from these holes. The problem then resolved itself into designing a test jig which should show whether the castings would finish to the required dimensions.

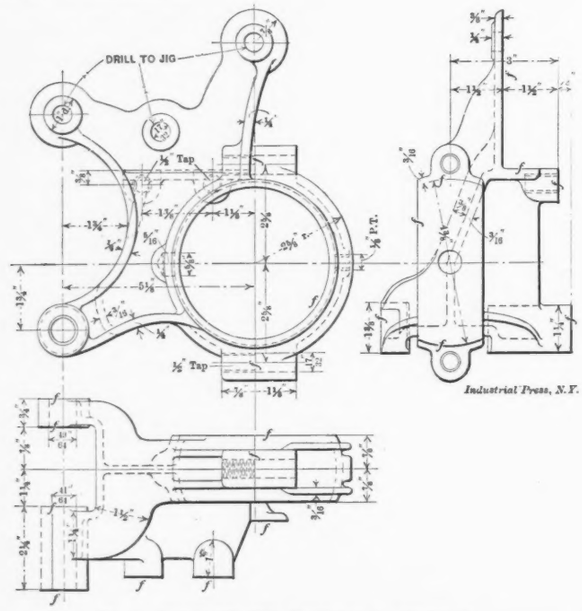


Fig. 1. Automobile Side Bearing to be Machined.

Fig. 2 shows the testing and planing jig with the work in position. *A* is a cast-iron plate to which is fastened a bell-shaped bushing *B* and two studs *C*. On the studs is mounted a cast-iron plate *D*, which in turn is threaded to receive another bell-shaped screw bushing *E*. The work is placed in position with the 1⅜-inch lug in the bushing *B* and the bushing *E* is screwed down on the 1¼-inch lug, bringing the two lugs in line. *F*, shown in the upper view, is the locating gage; it is a cast-iron block free to slide between pins. By pushing it up against the bearing the socket part of the casting is brought in certain relative position with the lugs. The jacks *G* are then screwed up against the casting and the whole thing is held down by clamp *H*.

The operation in this jig is the planing of the surfaces marked *f*. *I* is the gage for setting the tools for planing the 2 7-16-inch distance from the center of the socket; the gage is mounted on one of the studs, *C*, and is made 1-32 inch short of the required measurements, a 1-32 inch thick metal strip being used between it and the shaper tools. The stud is spotted for the setscrew to allow the gage to swing out of the way while planing and to be brought to the same position for the next setting of the tools. *J* is the gage for getting the 1½-inch and the 3-inch measurement from the horizontal center of the socket. The gage is free to move on the stud; the 1¾ inch part is set even with the sides of the socket and the shaper tool is set to the locating points of the gage. All the subsequent operations are performed from the surfaces planed in this jig. It will readily be seen that if the casting can be made to clean up it is safe to go ahead; the only exception

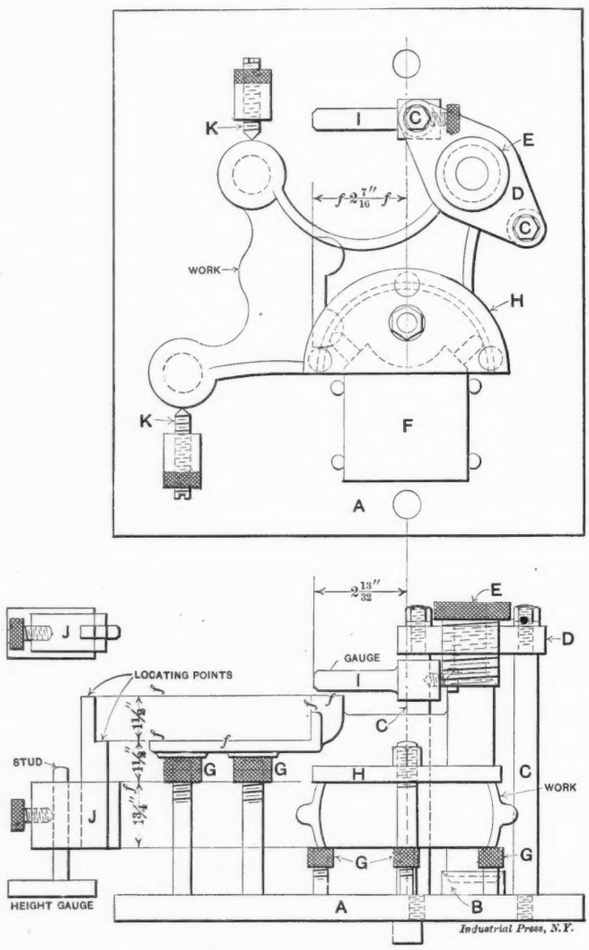


Fig. 2. Testing and Planing Jig.

is the cap stud holes, which had to be drilled to each cap separately. Of course while testing, it is necessary to clamp the work down, screwing down on the bushing being sufficient. The testing is done by placing a scale across the surface to be planed and moving the gage under it. The two setscrews, *K*, shown in the upper view, are to keep the work steady while being planed.

The jig for drilling the three 17-32 holes, the two ½ inch tap holes, the 41-64 inch and 49-64 inch holes is of the simple box type, built up from cast-iron plates, and need not be shown. The jig for planing the joint surface for the cap is also a simple affair, consisting essentially of a cast-iron angle plate to which the casting is clamped in a vertical position, using a shaft through the 41-64 and 49-64 inch holes for locating same in conjunction with a stud fitting in the 17-64 inch hole. This jig is also used for drilling the cap stud holes.

The next operation is the boring of the socket, which is done with the cap in position. The tool used for that operation is, I think, worthy of some notice, and details are given in Fig. 3. *A* is a steel forging, *B* is a turret lathe holder revolving on a taper bearing; the surface marked *f*, in the end view, should be made a good scraped fit. A square 5-16 inch Novo steel cutter is inserted in the turret lathe and held down with a setscrew, as shown. The two operating stud nuts, *C* and *D*, are inserted in the holes drilled in the body of the tool and the tool-holder *C*. The turret nut is threaded to receive the screw *E*, and both are free to turn in their bearings. By turning the screw the tool-holder is made to revolve, and the tool being set the proper distance from the center (a suitable gage is provided for that purpose) the hole is bored the proper shape to fit a 4⅜ inch ball, provided the tool is set exactly central.

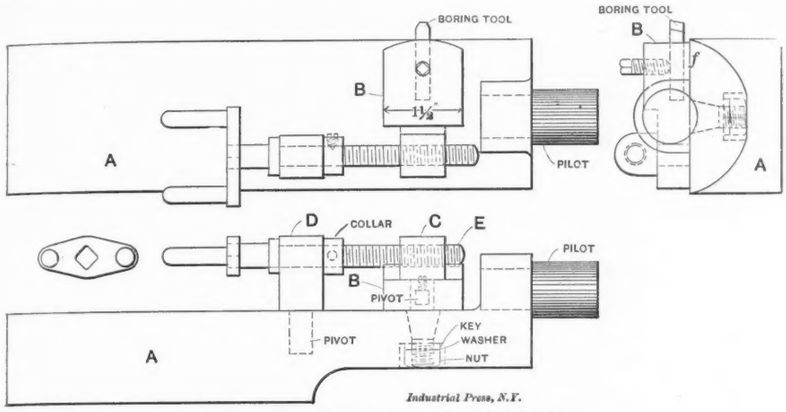


Fig. 3. Lathe Tool for Boring Spherical Socket.

How the tool is set central is shown in Fig. 4, which is the boring tool and jig for holding the work. *A* is a cast-iron plate fastened to a faceplate of a lathe. The work is located and held in the jig by the 17-32 inch hole, as shown at *B*. A hardened steel bushing forced into the jig acts as a bearing for the pilot. The tool is clamped to the carriage of the lathe so that the pilot will enter the bushing; bringing the shoulder of the pilot against the bushing brings the tool central and the proper distance from the planed surfaces and the previously drilled holes.

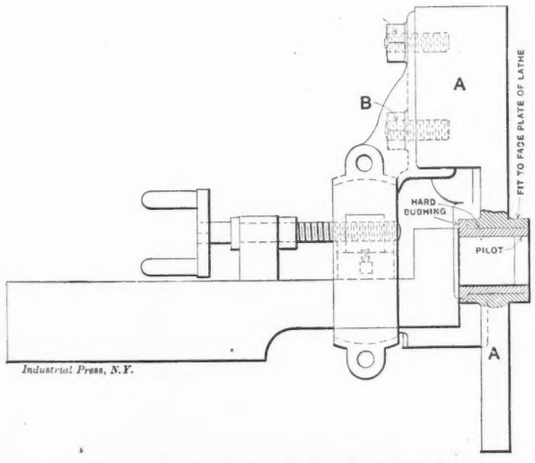


Fig. 4. Method of Holding Boring Tool Central.

L. MYERS.

Philadelphia, Pa.

HARDENING WORK IN PART.

Editor MACHINERY:

Referring to the letter from O. M. B. in the June issue on the subject of casehardening work in part, there is perhaps one shop in fifty that is equipped to turn out a job in this way, i. e., by applying a coating of copper by means of an electrolytic bath or otherwise. The carbonizing method is not at all bad, but by this means we are not sure of the desired result, and, furthermore, this process requires the services of a pretty good hardener. But any one can mix fireclay to the consistency of soft mud or dough and apply same to the piece to be hardened, on those parts that are wanted soft. The bare parts will, of course, be exposed to fire and water and will harden. If a large portion of clay is to be used on a piece and there is danger of same flaking or falling off, it may be secured by wrapping it with a sheet of asbestos and binding with wire.

IRM J.

[The above, of course, applies to the hardening of steel already containing sufficient carbon to cause it to harden. It is also true that fireclay can be used in the casehardening pack, to prevent the bone coming in contact with the work where it is wanted soft. For that matter any non-carbonaceous matter that will stand the heat will answer equally as well. Sometimes the part to be left soft will be wrapped with a strip of sheet iron, or will be protected by a short piece of iron pipe.—EDITOR.]

ADVICE TO YOUNG MECHANICS.

Editor MACHINERY:

This is written for the perusal and thought of the young mechanic, employed in the small machine- and instrument-making shops, that is, those who have been employed upon one line of work and have become accustomed to the one method of working.

It would be more to his interest after spending three or four years in such a place, to secure another position, with a large firm employing the more modern methods and machinery for producing accurate and maximum amount of work. For he will find to his regret if, after being employed for twelve or fifteen years in the one place, he is compelled to secure another position with another firm, that it will be rather difficult to become accustomed to the new methods and machines.

Always keep yourself well informed of the new machines and methods constantly being introduced, by subscribing to the various mechanical papers published. I can recite numerous instances where I have secured valuable information from the pages of MACHINERY.

Always be accurate in your work—never let it leave your hands in the condition known as "good enough," but make it perfect. It will give you and your employer more satisfaction. It will indirectly bring the best and most accurate work to you, and secure to you the confidence of your employer.

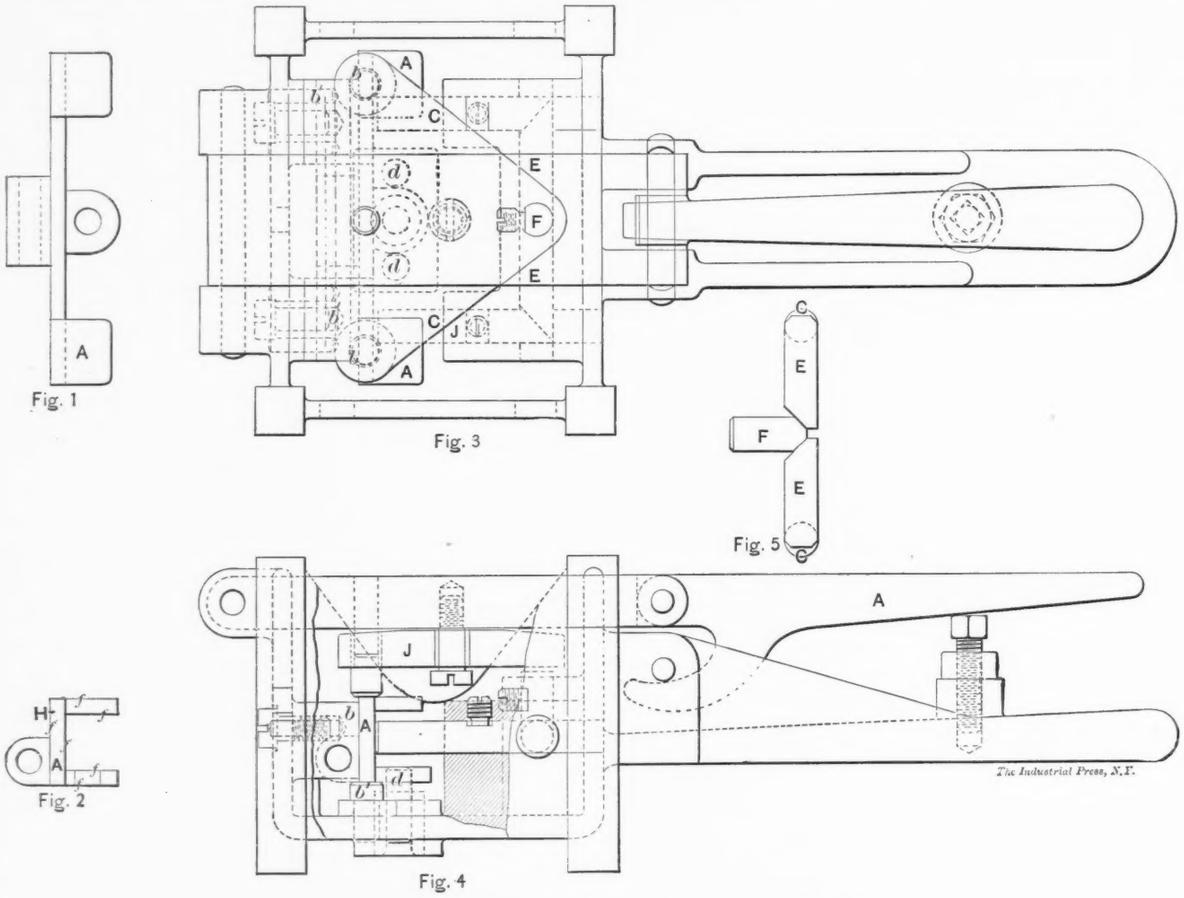
Do not become a specialist, that is an expert on one machine or one line of work only; try if possible to become an all-around mechanic, able to work on the milling machine, shaper, planer, engine or speed lathe, with accuracy and skill. This is very hard to do at present, especially in large places, where the work has been systematized and specialized, for one seeking employment in these large places generally secures it as a lathe, miller, planer, or vise hand. Therefore the advisability of being competent to work on all. In the smaller shops you can generally secure an opportunity to work on all of these machines, but they are usually of an old model, lacking most of the newer accessories.

Therefore, my advice for the young mechanic is to change his positions while young, so that when older, if through loss of position he is compelled to change, he can do so with less worry and more confidence in his abilities.

When entering a new position and securing work upon a machine that you are not familiar with, study it, master its mechanical movements and proceed carefully, taking no chances by throwing in automatic feeds, etc., while the machine is in motion. I have seen numerous so-called good mechanics do this, with disaster, thereby tearing out the tooth of a gear, or breaking some other part of the machine, also losing their positions. If you cannot master the movements of the machine or think them out by yourself, do not fear to ask your foreman or whoever you are working for. Swallow your pride. It

is much better to acknowledge your ignorance and ask one or two questions, thereby saving yourself and employer a great amount of delay, trouble and expense for repairs. Do not fear to take advice from some who have had more experience than yourself; you are young and do not know it all. Take the advice, think it over, and if valuable, use it by all means.

Keep your mind only on what you are doing, proceed carefully and be accurate. The skill and speed will come without your being conscious of it, and remember one bad mistake outlives one thousand good pieces of work, for it is generally the mistakes that are remembered by your employer when you ask for an increase in salary. R. L. F.



Drill Jig with Equalizing Clamp for Exactly Locating the Work.

DRILL JIG WITH EQUALIZING CLAMP.

B. P. Fortin.

Editor MACHINERY:

The growing demand for machinery and the competition have necessitated the introduction of improved tools to reduce the cost. Jig and fixture designing has come to be a trade by itself; undoubtedly there is no branch of the mechanical business which requires so much practical experience as in this particular line. A poorly designed tool is a very costly thing; hundreds of dollars can be wasted in a short time with an inferior one. On its accuracy, simplicity and quickness depend quality and quantity, hence cost of product.

There are a number of obstacles to be overcome in accurate jig and fixture designing. The clamping must be done quickly and without springing the jig or the work; then provision must be made for easy cleaning out of chips, and another very important thing is, that it must be so constructed that it will be impossible to get the work in the wrong way. For as I once heard the boss of a manufacturing department say: "If there was any possible way for them to get work in the wrong way they will do it" (meaning the operators). It is important to make drilling jigs as light as possible. To obtain lightness, just as little metal must be used as is necessary to sustain the strain brought to bear upon the parts. All metal should be so placed as to be in line with the strains exerted thereon, therefore, jigs should be box-shape. The advantages obtained are manifold, for, while they are light, they are also easily cleaned. Some of the older manufacturers still advocate the use of heavy drilling jigs—large cumbersome things and slow to handle. Their reason is that a light jig will not stand the rough handling. While that is true in a way, is there any necessity for such rough usage? In my opinion, No! A proper system in the manufacturing department would do away with this.

It is customary in a good many of the large shops in the Eastern States to hire green men and boys to operate their jigs and fixtures. If it is a drilling jig, especially a small one, the gang drill is set up for that purpose, each spindle in rotation is set up for its respective operation. The men that set these machines are competent machinists and they always keep one or more machines set up for the first one who gets out of a job. They are also responsible for the quality and quantity of work turned out. For instance, a drill or reamer may get roughed up and in this manner spoil the work or a drill bushing. Therefore, it keeps the machinists in charge on a constant lookout. The operators are provided with a gage and a sample piece which is correct. They are instructed how to use it; also to try every few pieces to see that they are coming like the sample. In this manner one good man can keep a dozen cheap ones straight.

The design presented in the accompanying illustrations, Figs. 3, 4 and 5, shows clearly the most practical designs and construction for a quick clean jig. Figs. 1 and 2 show a special drop forging, finished at the points indicated by letter *f*; and there were two holes to be drilled at right angles to each other. The jig for drilling the piece is shown with work

fastened within it in the plan view, Fig. 3, and the side view, Fig. 4; detail of clamp arrangement, Fig. 5. As the side *H* is the particular side it had to be gaged from that side. The work rests on the gage points, *b b*, and is pushed back against the gage block *b' b'*. It is located end ways by the two pins *d d*, as there was not sufficient room for a bushing. The drill was guided through block *b' b'*. The hole drilled from the block had to be very accurate, therefore it was found necessary to run a line reamer through the work. It had a long teat which was guided in the opposite block. This reamer had an end cut only, with sharp corners and two flutes for chips and oil.

The clamping is done by the handle *A* through the opening of the pins, *E E*, *C C*, and *F*. Simultaneously at two points it forces the work down, and also against the block *b'*; at the same time the auxiliary piece or clamp *J* is allowed to float, to take up the slight variation in the piece. Fig. 5 shows clearly how each pin was beveled on the end to push its adjacent pin forward.

The first operation was a drill, fitting the guide hole for a start. Then a drill was run through the work, after that came a rose reamer, then the line reamer. It was the same for the other hole with the exception of the line reamer. The rose reamer in this case finished the hole. A jig of this kind can be used to the best advantage on small finished work. Small rough castings vary so that they make trouble.

Philadelphia, Pa. B. P. FORTIN.

PARALLEL MOTION FOR DRAFTING TABLES.

Editor MACHINERY:

Some time since it became the duty of the writer to fit up a drafting room, and as parallel motion was desired on all tables, it was necessary that an article be procured that should be of low first cost, accurate in its action, and requiring but a minimum amount of attention. The market was looked over with the idea of buying, but as it was desired to manufacture all apparatus for factory use—provided the cost would not exceed that of the purchased article—the motion illustrated was designed.

The majority of the boards were 33 inches by 55 inches, and were fitted with heavy braces running their entire width (which were drilled out at the proper place to allow the cord to pass freely through) and supporting the adjusting legs. The larger tables were 3 feet by 8 feet and 4 feet by 12 feet. The only change in the entire equipment was in the length of the straightedge, the guard for the cord, and the cord, which was about 1-16 inch diameter. Each end of the board was provided with a guard to protect the cord—as shown in detail—preventing all chance of accident to the cord; it was "rabbeted" to allow free movement of the clamps *K*. This guard also supported the pulleys, and, being firmly attached to the lower side of the board, helped, in a measure, to prevent the tendency of the board to warp.

The straightedges were purchased from a supply house and were slotted at either end, allowing fully one inch in excess of length of the tongue on the distance piece *D*. The binding clamp *K* was made of sheet metal, drilled to a clearance for the binding screw *S* to pass through, and fitted loosely in the distance piece *D*, which was grooved on its lower portion to prevent the clamp *K* from rotating while being tightened, and was tongued on its upper portion to move freely in the slot in the straightedge. This arrangement made it impossible for the clamp to rotate while gripping the cord, and was easily adjusted for the insertion of a new cord; it also made it an

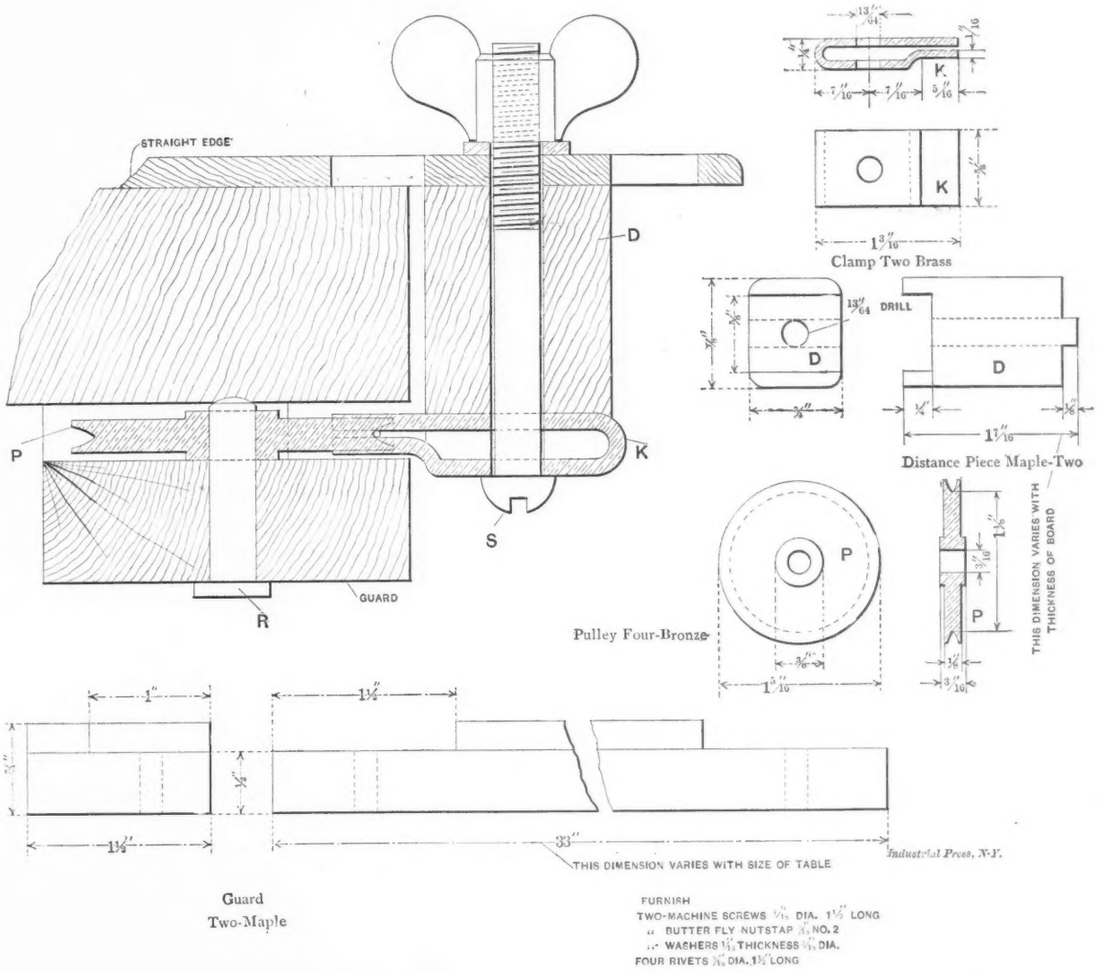


Fig. 1. Details of Parallel Motion for Drafting Tables

easy matter to change the straightedge from the horizontal to an angular position in drawing the conventional screw thread, etc. The pulleys *P* were made of brass, drilled out to rotate freely on the iron rivet *R*, and were grooved to receive the cord. The dimensions given on the illustration are for a board ¾ inch in thickness, and as the board increases in thickness, the length of the distance piece and binding screw

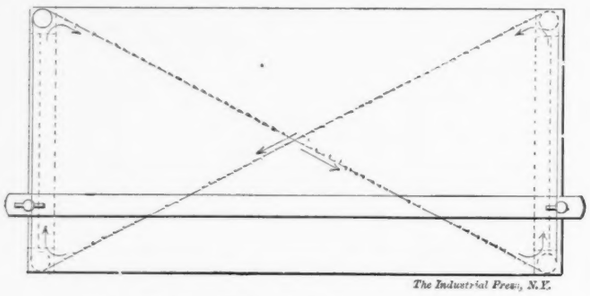


Fig 2. Showing Plan of Connections to Straightedge.

will increase in like manner. The cord used is braided linen fish line, and in daily use has worn for two or three years.

The writer does not doubt that there are parallel motions that are as efficient as the one described, but he has used several, and up to the present time has not found any that are more convenient and certainly none that cost less.

V. A. H.

ACCURATE JIG MAKING.

Editor MACHINERY:

I have just read with a good deal of interest the article on jig making by Mr. Frank E. Shailor in the July issue of MACHINERY, and having myself used the methods of spacing the holes he describes, can vouch for their accuracy, when the conditions for doing the work are right. Toolmakers who have worked in a number of shops, however, can testify that milling machines with corrected screws are mighty scarce, and also that in some shops where great accuracy in the work is demanded, the machine equipment is sadly deficient in the qualities most needed for accurate work. I have in mind a shop in Brooklyn in which I worked for several months, where the limit of error was 0.001 inch in parts of the work, and 0.0001 inch in other parts of the work, and whose tool equipment was worn so badly from years of usage, as to make the use of the feed screws out of the question for accurate work.

However accurate a screw is on a milling machine when new, it soon loses its truth if used under the ordinary conditions of machine shop practice, since only a small portion of the screw is used to do most of the work of driving the table, and that too under all conditions of cut and feed. Now I would have nothing to say against this method if I knew of none better, but I think the method of spacing holes in jig plates that I described in the October, 1902, number of MACHINERY is the better of the two, and believe it should be brought to the attention of your readers again.

This method is one by which the plates are placed on the table of a drill press of the sensitive, or semi-sensitive type, depending on the size of the plates to be drilled, and held to position by gages, readily and cheaply made, and the position of the bushing is spotted by a pilot drill guided by a bushing, which is in turn held by a bracket fastened to the frame of the drill press. The pilot drill is driven in, only about one and a half times its diameter at first, to avoid making too many chips, the holes being drilled through after the bushing bracket is removed.

I have tried two methods of opening the holes to the reamer size, both of which proved to be good, but the first required a little more care than the second. The first consisted of using the half-round 60-degree center reamer to open the mouth of the hole to a diameter slightly greater than the reamer size, and then drilling out to reaming size with a drill very carefully ground to have its cutting lips even. The drill should be quite short and run true in the chuck. The second method consisted of using a counterbore having a pilot that fits the hole made by the pilot drill, and counterboring the hole out, leaving enough metal for the reamer which is to size the hole for the bushings, in both methods.

The advantages of this system over that of the milling machine and button methods are many and apparent after a little study. One advantage is in getting ready, the supposition being that the main parts, such as parallels, bracket, bushing, etc., are made. A second advantage is the slight chance of error in making the changes, if the gages are marked distinctly. Again, nearly all shops contain an equipment that will permit the use of this method, with but little outlay for getting ready. The gages are made of brass, steel, or iron, the length being obtained by micrometer or vernier calipers, and if the plates are small, no change is necessary in the drill press arrangement, except the making of the bushing bracket.

I once worked in a shop where the back-lash on the feed screw of the milling machine was at one point nearly a quarter revolution of the screw and at the end was quite a nice fit, the machine being quite old. I had a job to do that required very nice measurements, and succeeded by using the stop on the table, and making gages of drill rod to give me the distances to move.

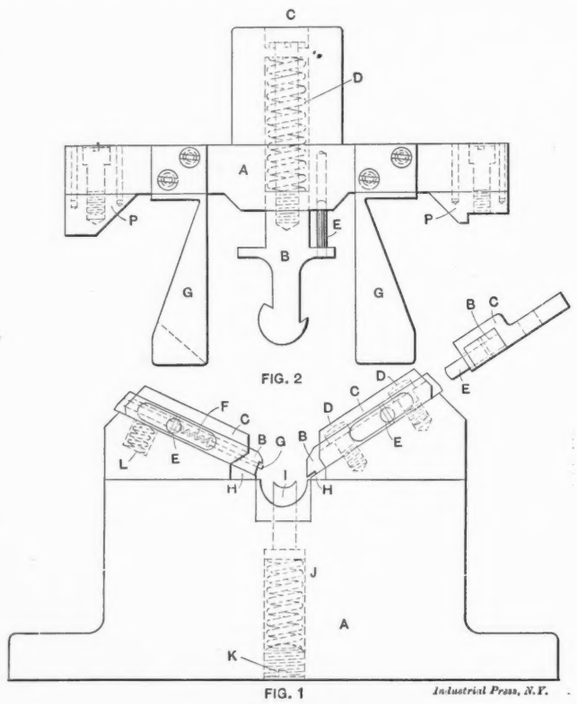
J. R. GORDON.

Brooklyn, N. Y.

PUNCH AND DIE FOR MAKING HINGE SPRINGS FOR NOVELTY BOXES.

Editor MACHINERY:

The cut Figs. 1 and 2 illustrates a punch and die for bending a sheet steel piece to the shape of the spring shown in Figs. 3 and 4. This piece was afterwards given a spring temper and was used as such. The spring in question is used on small novelty boxes—such as jewelry boxes, etc.—it being snapped on the hinge to prevent the cover of the box being thrown back beyond a vertical position, and also to keep it closed with

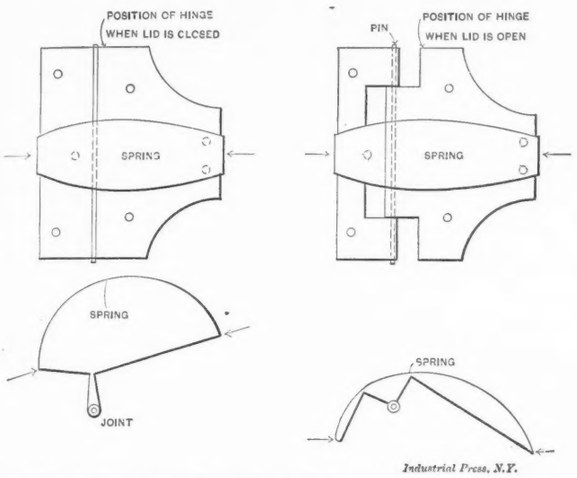


Punch and Die for Making Hinge Springs.

some little tension when down. The demand for these springs was such as to warrant the making of the punch and die for the purpose of adapting it to the rapid handling and bending of the spring complete at one stroke of the press. The spring is made from high carbon sheet steel 0.012 inch thick, which was first blanked out in a cutting die the required outline and length.

Those who have essayed bending tool steel in a die for the first time have probably not been pleased with the experiment, and usually not satisfied with their success, especially when

a high degree of accuracy is required. In this instance, moreover, the difficulty of developing the exact shape and the added difficulties of securing successive lots of steel of the proper carbon and anneal to make the continuous production the attainment of uniformity, grow very rapidly in the production of a piece of this type; even with previous experience on this class of work we were forced to make two or three of the pieces that constitute the forming die, and experiment considerably before the perfect development was reached. An experienced punch press hand is essential to operate a die of this kind. It is pretty safe to say that in a tool of this design when two blanks, one on top of the other, are put in the die—which is seldom—that something will happen. We experienced this misfortune soon after constructing our first die, and the chances are, as was the case with us, that a new die will be cheaper than attempting to repair the old one.



Figs 3 and 4. The Spring Hinge shown in Closed and Open Positions.

The use of the cams to move the slides outward we find is particularly better than springs, in view of their positive action, which decreases to a minimum the liability of an accident. An accident in this type of die is self-evident should the slides for any reason be in a position with their inner ends over the shoulders on the punch during the upward movement of the press ram. The capacity of these cams for this particular type of die is extensive. Of course, the angle is measured according to the movement of the press ram; it can be varied up to 45 degrees.

The punch and dies shown in the illustration and now to be described consist of the die, Fig. 1, and the punch, Fig. 2. The base *A*, Fig. 1, is of cast iron and carries the rectangular hardened steel slides *B B* secured thereon by caps *C C* and four 5-16-inch filister head screws *D D*. The two screws in the left cap are omitted for the sake of clearness in the drawing. The front of the caps are provided with elongated slots through which project the hardened ¼-inch pins *E E* that engage with the cams on the punch to throw the slides outward. The pins extending through the slides are retained rigidly in place by small pins driven through them. The pin in the left slide insures the maintenance of the spring *F* and sliding pin *G* in proper position. The base *A* is cut away at *H H* to gage the work. On the downward action of the press the steel blank is clamped between the punch and the square piece *I*, which is supported by the compression spring *J*. Directly beneath it, to provide for the adjustment of the tension the blind screw *K* is provided. To provide for and control the necessary steady action of the slides, and to prevent a loose movement, which must naturally take place after a short run on account of their inclined position, a spring *L* is located beneath each slide, the one on the left only being shown in the sketch. The right spring is omitted to avoid obscurity.

Fig. 2 shows the punch in detail: *A* is the holder, *B* the punch proper, held in its downwardly extended position by the screw *C*. Back of the former is the stiff spring *D*, essentially of a strength sufficient to bend the blank down in the die before any perceptible contraction takes place. Pin *E*, with the upper end fitted freely in the holder keeps the part *B* from rotating. The inclined faced pieces *P P*, fastened to the holder by screws and dowel pins, on the extreme downward movement of the ram, force the slides in and make the sharp end bends on the work. Seated in the holder to insure true parallelism and angular displacement, and secured thereto by screws are the cams *G G* made from ¼-inch thick tool steel, with their working surfaces hardened to obviate abrasion. They project forward just sufficient to pass down and close to the front of the die, where they engage with projecting pins in the slides. When the punch is up to its extreme height the lower ends of the cams are in contact with the pins; in fact, they are never entirely clear of the die. When the press carries the punch up beyond the die we usually machine away the lower corners of *G G* at about the same angle, as shown by the dotted line on the left-hand piece, to avoid striking abruptly on the pin in the slide, if for some accidental reason they should chance to be in when the press is tripped.

All working parts of the punch and die were hardened and drawn, as is consistent with good practice, to insure the life of the same. The press is run at a high rate and tipped back on an incline, as the expansion of the work was sufficient to allow it to fall by gravity from off the punch, and therefore allowing the blanks to be constantly fed to the die, increasing materially the daily production. C. H. Rowe.

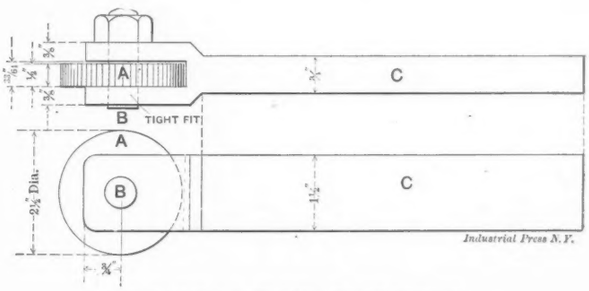
Worcester, Mass.

LATHE ROLLER FOR FINISHING SURFACES.

Editor Machinery:

We have in use at the shop I am connected with at present a lathe tool which can be very easily and cheaply made and would, I am sure, be appreciated by at least some of your readers, for while we use it here, it seems a new thing to most machinists who come to our shop. The enclosed sketch is self-explanatory.

Roller *A* is of tool steel turned and hardened and revolves freely on pin *B*, while yoke *C* is a steel forging. After the ordinary roughing cut is taken practically to size, this tool is placed in the tool-post and brought to bear quite firmly against the piece being turned and fed for the length of surface required to be polished. The result will, I am sure, both surprise and please any one who has not used this tool before. This tool gives a more satisfactory finish to a shaft than any other way I know of, for it not only insures the shaft being perfectly true but it seems to harden the surface of the shaft



Lathe Roller for Finishing Turned Surfaces.

so as to make a very noticeable difference in the life of same. I trust that this will be given a trial by those who have never before used it. The dimensions given are not arbitrary but work well. R. F. Kiefer.

Cleveland, O.

[Undoubtedly this tool will be new to many as it was to our correspondent, but it is one that has been quite popular in locomotive repair and building shops for years. Its chief use in such shops has been for smoothing and compressing the surfaces of journals, and for finishing piston rods and valve stems. Driving axle journals finished by rolling generally run cool from the start and they wear considerably longer than when file-finished. The turned surface should, however, be as true as possible before rolling for, while the roller does tend to correct local inequalities, it does not correct a general want of truth, as is the case with the grinding machine.—Editor.]

BORING BAR ATTACHMENT FOR PLANER.

Editor MACHINERY:

The superintendent of the Riehle Bros. Testing Machine Co.'s works in Philadelphia, Mr. W. J. Tretch, having occasion recently to do a heavy job of boring devised the rig shown in the accompanying sketch, utilizing one of the shop planers as a horizontal boring machine. A portable drill press *C*, Fig. 2, bolted to the back side of the cross-rail, furnishes driving power. In the Riehle works the power is supplied to this press from one of the several rope drives which, stationed at convenient intervals, furnish power to portable tools on the erecting floor. Power could be supplied as well from an electric motor or a special countershaft. To the apron of the planer is bolted a yoke *B*, which carries the bearings for the boring bar *D*. The journals are large cast iron sleeves fitted to the boring bar by a sliding key; the key-way extends the full length of the bar. By this means amply large bearing surfaces are secured, rigidity is given to the bar, and the bar itself does not wear in use. The tail support *E* is a similar bearing supported by a slotted angle piece which is bolted to the planer table.

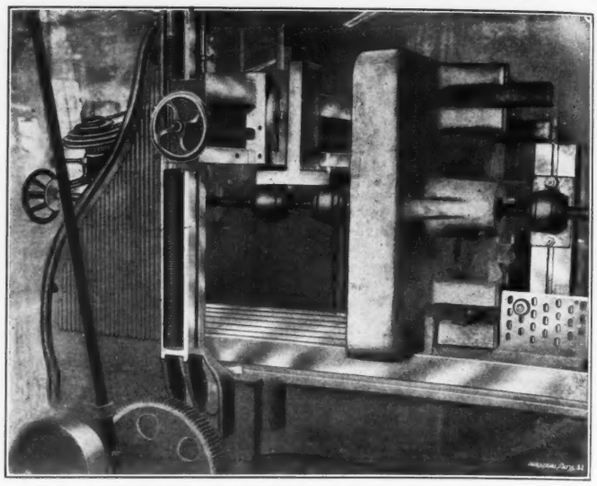


Fig. 1. Front View of Boring Bar and Job on Planer.

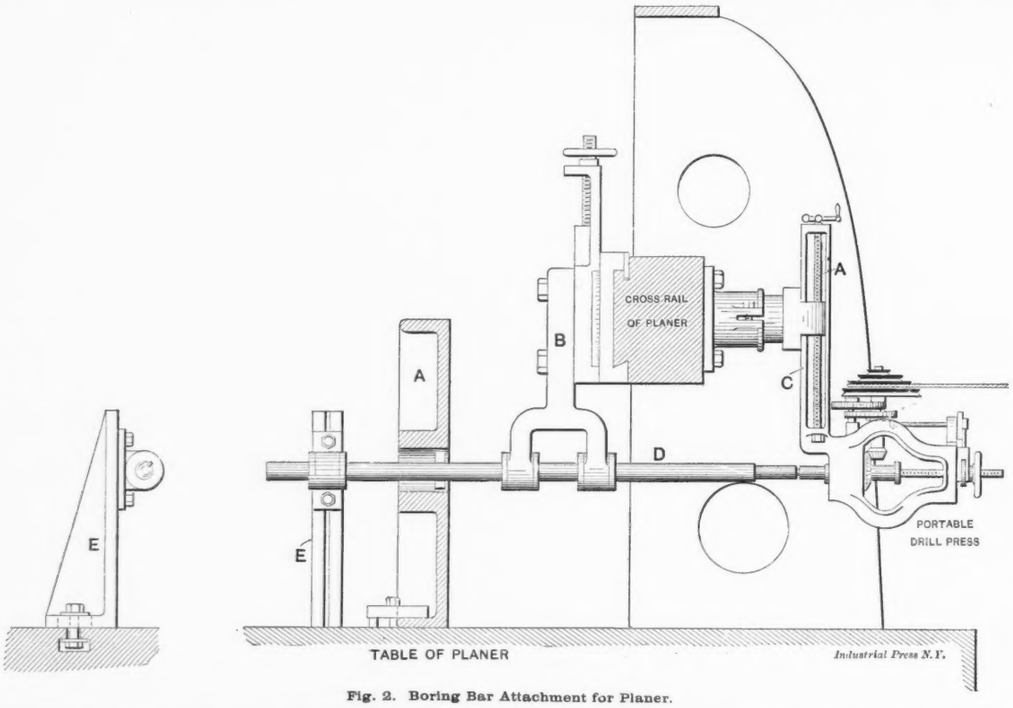


Fig. 2. Boring Bar Attachment for Planer.

The apparatus has given excellent satisfaction in the Riehle shops, being frequently used since its first installation. The above attachment would be specially useful to those shops which have occasional use for a horizontal boring mill, but not frequent enough to use to justify the purchase of that expensive piece of apparatus. With a 2-inch bar holes up to 10 inches in diameter can be bored.

Philadelphia, Pa. H. F. MOORE.

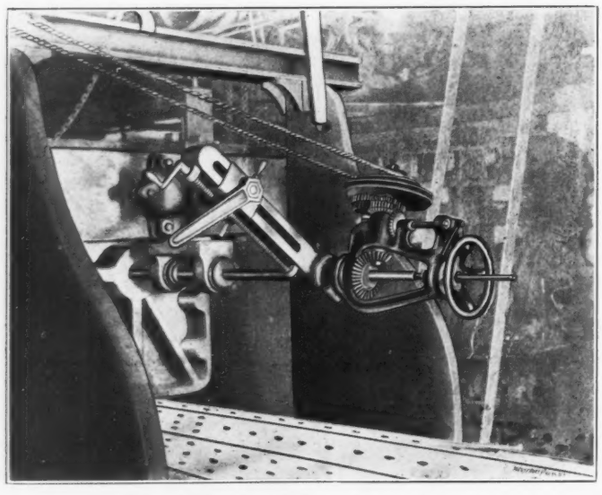


Fig 3. Rear View of Boring Bar on Planer

ANNEALING HARDENED STEEL LOCALLY.

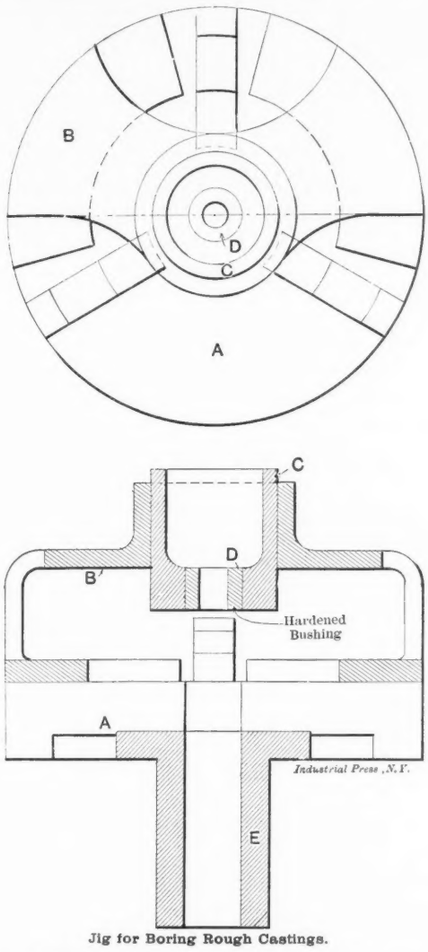
Editor MACHINERY:

The articles which you have been publishing from F. J. K. and Harry Ash in regard to the annealing of hard spots in steel or softening limited areas in hard steel have interested me somewhat, although there are simpler and more practical methods by which the desired results may be obtained. I have in mind two methods which may be used to advantage in work of this character, and either of which I consider superior to those previously suggested by F. J. K. and Harry Ash, although their suggestions are good.

Where a hard spot is encountered in a piece which is desired soft throughout, the piece may be held in a fine gas blast which almost any shop or mechanical room is provided with. This will very readily bring that portion of the piece to which the blast is applied to a soft condition, and will work equally well where it is desired to soften a spot in a hard surface or hardened section for the drilling of holes, tapping, etc. By

regulating the heat given the piece, almost any degree of softness desired may be obtained.

Where a gas blast cannot be conveniently procured, an extremely effectual and simple method is to place a small ring over the spot that it is desired to soften, and then pour molten lead into the ring. This, of course, brings the molten metal in contact with the hard spot or surface, the ring preventing the lead from flowing beyond the point being treated, and confining the softening to the space desired annealed. The degree of the softness desired can be regulated by the capacity of the ring, a considerable quantity of lead bringing about a very soft condition. If only a slightly annealed space is



Jig for Boring Rough Castings.

desired, a small quantity of the molten lead will do the work. To one who has never tried this method of annealing a spot, it will be surprising to note what may be accomplished by the application of the heated lead. In a machine shop it will often be found desirable to have a certain portion of a hardened piece annealed slightly for cutting a key-way, drilling a hole, or other machining where it is not desirable to subject the entire piece to the annealing heat, and in such instances molten lead can be used most advantageously.

IRM J.

ANOTHER JIG FOR BORING ROUGH CASTINGS.

Editor MACHINERY:

Referring to the letter in the June issue of MACHINERY by Mr. Cyril B. Clark in which he describes a jig for boring rough castings, containing three moving jaws, the way we bore gears and sprocket is as follows:

We took a 15-inch three-jaw combination chuck *A* and fitted over it the casting *B*, which holds the large cast iron bushing *C*. By making the stem *E* of the chuck faceplate of the same size as the stem of the drill press table, the jig is quickly centered. The large bushing *C* holds another smaller bushing *D* which is hardened and which serves to guide the drills. The small bushing is readily removable and can be exchanged for others as the work may require. We use three-groove chucking reamers with this jig, as all our castings are cored. This arrangement gives us a jig that will hold all sizes of castings that will go into the chuck.

FRED GINKEL.

Syracuse, N. Y.

RUSTLESS SOLDERING SOLUTION.

Editor MACHINERY:

Replying further to C. W. B.'s inquiry for a rustless soldering solution I have at hand a formula which is claimed to be rustless, but I have never tested it. It is simply a saturated solution of zinc chloride in grain alcohol.

In using a rustless soldering solution, care should be taken to have a soldering bit that has never been used with acid, as the copper absorbs enough acid to cause the work to rust even though the solution is a rustless one.

Syracuse, N. Y. GEORGE G. PORTER.

USE OF CARBORUNDUM WHEELS.

Editor MACHINERY:

For tests of their merit I have been grinding and experimenting with the different grits and bonds of these wheels on all sorts of stock, such as hard and soft steel, cast iron, cast steel, malleable and chilled iron, brass, bronze, aluminum, slate, the various grades of rubber, wood fiber, cork, glass, granite, china, stone, brick, leather, wood, asbestos, carbon, in short, almost everything used in the arts and for manufacturing purposes. I have even successfully ground the ends of the bristles on a reel brush, one inch or more in length, making a true and even surface.

As there is a difference of opinion, it may be of interest to users of these wheels to learn, from practical experiments made, which is the proper way of grinding paper, planer or other knives. Some claim the knife should be set with the cutting edge toward the motion of the wheel; others from the motion. In my tests made on this work, I find that without doubt or question the proper way is to run the wheel toward the cutting edge, and with the edge up. After a number of tests made both ways, I soon found trouble with the same wheel on the same work, in running the wheel from the cutting edge because of glazing, and heating the knife, which, of course, follows after glazing. While running toward the cutting edge there was no trouble from either glazing or heating. From close observation I find this is accounted for in this way. When the wheel runs toward the cutting edge (the proper way) it removes the tempered or hardened portion of the knife first and these hardened particles are carried down between the wheel and the softer portion of the knife, assisting the wheel in removing the softer portion and keeping the interstices of the wheel open and cutting qualities in good shape. When we set the knife with its cutting edge (the hardened portion) from the motion of the wheel and we first remove the softer portion of the knife, the particles of which have little abrasive power, and as they are carried down between the wheel and the hardened portion, they obstruct its cutting qualities by being rubbed or pressed into the pores or cutting cavities. This soon fills them up and glazes the wheel, acting the opposite to what it does in running toward the cutting edge (the proper way). I will be glad to hear from any one interested in grinding about this or any other points of interest, and I hope to give further interesting facts regarding the carborundum wheels later on.

EZRA F. LANDIS.

La Salle, N. Y.

A CRITICISM.

Editor MACHINERY:

In the first article of the present series on "Tool-Making," by E. R. Markham, he asks the experienced toolmakers to overlook that which he writes, as it is intended only for apprentices. I think it is bad practice to set forth methods and appliances intended to enlighten the apprentices if in after years the apprentice is obliged to discard the primitive teaching and begin anew. For this reason I take exception to the statements by Mr. Markham that I know from actual experience will prove misleading to the apprentices of to-day.

For instance, in making a screw-cutting die, Mr. Markham

advocates the use of a screw that fits tightly in the die while drilling the clearance holes around die. I claim that a screw tightened in a soft die to that degree of tension necessary to prevent the screw from turning when drilling the clearance holes will stretch the thread. After hardening the die, the lead will change again and invariably one error multiplies the other, producing a die the lead of which is far from that intended.

Again, Mr. Markham carefully leads the inexperienced along, pointing out this and that which should be avoided, and at the critical point discards the use of care entirely, and proceeds in such a manner that if the work produced is true, it is "bull luck" and nothing else. I refer to his description of accurately locating the center of a thread-cutting die. Mr. Markham says: "After truing faceplate and carefully indicating the prick punch mark (even the necessary precaution of removing the belt to prevent lacing vibrating lathe), proceed to drill the hole. After drilling the hole, bore it to desired size *unless* a reamer is at hand that will produce the desired tap size hole."

My advice to apprentices is, never ream a *drilled* hole if said hole is of a nature that it is necessary to indicate same in a lathe. The drill may start perfectly true, but it is once out of a thousand that it continues true clear through the work. Hard spots in steel, drill becoming dull, one lip doing a trifle more cutting than the other and crowding the drill, are elements that will tend to make the drill "crawl" away from the center. I have seen a reamer cause a hole to run out of true when used simply to size hole after boring. Probably there was a dull tooth on the reamer, but nevertheless *bore* all holes when the hole is desired central with work.

In my opinion, apprentices should be taught the most modern methods that help to produce accurate work, for the degree of accuracy that the toolmaker of to-day is obliged to work to is such that the best methods known are none too good.

Great Barrington, Mass. FRANK E. SHAILOR.

FROM THE INVENTOR OF THE TOOL FOR LAYING OUT HEXAGONS.

Editor MACHINERY:

The tool for laying out hexagons on the ends of rounds for patternmakers' use, shown in the July issue of MACHINERY, was invented by me over twenty-five years ago while working for Rumsey & Co., Seneca Falls, N. Y., pump manufacturers, for laying out the hexagon caps used on pump cylinders. Shortly after I removed to Ohio and made and sold some of them to patternmakers, and no doubt there is a large number of them in use among patternmakers. The included angle between the wooden side *C* must be very accurate, as any error is doubled in laying out, and it is necessary to use a very sharp pencil. G. E. BABCOCK.

Fort Plain, N. Y.

[In this connection it may be noted that an omission occurred in the cut, Fig. 2, which accompanied the editorial comment on this tool. A line corresponding to *BJ* should have appeared below *BL*, drawn from *B* and tangent to the outer circle, since the angle 70 degrees 32 minutes is included between these tangent lines and not between *BJ* and *BL*, as accidentally appeared in the cut.—EDITOR.]

FACING STUDS FOR LATHE CHUCKS.

Editor MACHINERY:

I send you to-day sketches of a handy little appliance that I call a facing stud, and one which I have found to be worth its weight in gold when used for facing flat disks in the lathe. I have had to make a large number of steel disks ⅜-inch thick by 11 inches diameter and have used the studs to great advantage. The studs are made of machine steel as shown in Figs. 1, 2 and 3. Fig. 4 shows a set of the studs in position in a chuck. They may be used with either a three or a four jaw chuck, placing one of the studs in each of the T-slots found in nearly all chucks.

Having plenty of stock on the rough disks, during the first operation I held them in the jaws of the cnuck with as short a grip as possible, and was thus enabled to finish-bore and turn them, also to take a rough cut over the face. For the second operation, the studs having been placed in position and faced off true, the opposite side of the disk was then faced to within 1-32 inch of finished thickness, this operation taking off the stock held by the jaws of the chuck during the first operation. The studs were then faced again, to insure their being correct, the disks placed in the chuck very carefully, bearing against the studs, and a cut taken off each side to the right thickness.

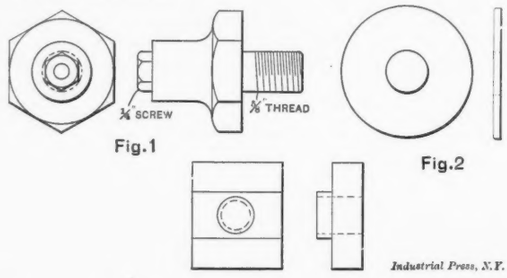


Fig.3

Facing Studs for Lathe Chucks

In chucking the disks for the last operation I was surprised and gratified to find how little pressure of the jaws was needed to hold the disks in place, as too much pressure would spring the disk and spoil the job. In a lot of 25 disks, the greatest variation found by the inspector was 0.001 inch.

The ¼ inch cap screws inserted in the end of the studs can

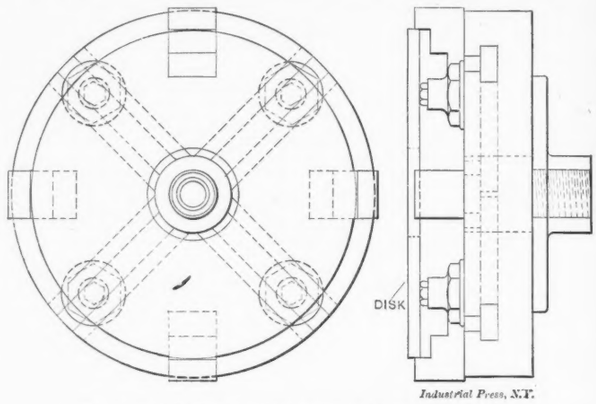


Fig. 4. Set of Facing Studs shown in Position in Chuck.

be removed when faced thin and replaced with new ones. I would add that neither the outside diameter nor the bore of these disks was required to be very exact. In re-chucking after the first operation, it was not necessary to true the disk edgewise very closely. RALPH B. CASEY.

Schenectady, N. Y.

* * *

A general knowledge of economical methods of making engine repairs, is a very valuable asset for a chief engineer. In fact he cannot fill the position in many power plants unless he does have this qualification. If a part becomes worn so that it cannot properly perform its function it is the natural impulse to replace it with another—and usually a costly impulse, too. Right here is where the skilled engineer and a "starter-and-stopper" will differentiate; in many cases the old part can be made to serve its purpose as well as a new one if the engineer in charge has the "know how." For instance, suppose the key connecting the piston rod to the crosshead is found to have worn in the rod so that it does not draw the rod into the taper fit, although it fits tightly in the crosshead and cannot be driven in any further. It is not usually necessary to throw away the key found in this condition, and make a new one. A good blacksmith can spread such a key so that it will dress down straight on the worn edge, and serve all practical purposes. The key is not widened by flattening the whole surface as this would make it thinner than the width of the key slot, but a narrow fuller is laid longitudinally along the center of the key, thus forming a shallow groove. The displacement of metal in the center in this way will easily spread a steel key all that is required in most cases.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

HENDEY CENTERING MACHINE.

The accompanying illustrations show a new centering machine brought out by the Hendey Machine Co., Torrington, Conn. This machine was not at first intended for market. One was originally designed and made at the Hendey shops to meet their own requirements for a centering machine, but it has been found so useful, and so well adapted to the work intended, that it is believed it will also meet the requirements of many other firms, and so it has been decided to place the machine on the market. Accordingly a lot of these machines have been completed and are now on hand ready for prompt delivery.

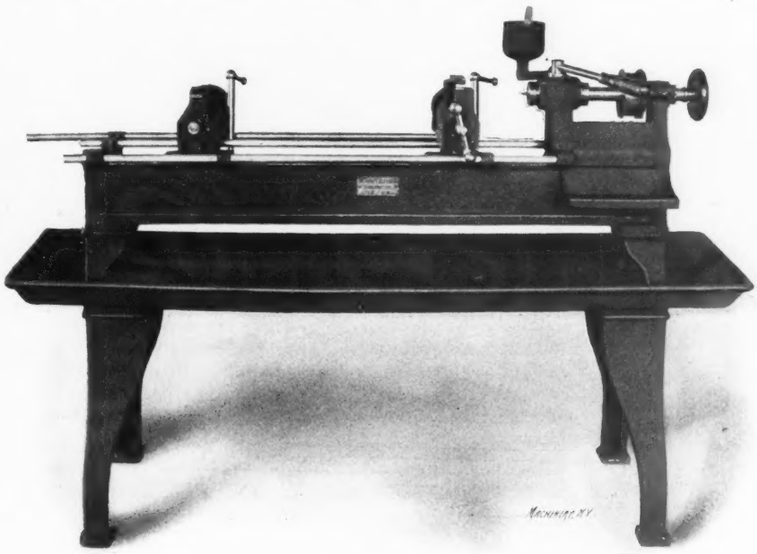


Fig. 1. Centering Machine made by Hendey Machine Company.

The machine is built with a rigid head having a single spindle permanently aligned with the ways of the machine, and large in diameter with ample bearings. The spindle is provided with a draw-in attachment with a watch-tool chuck for accurately and conveniently gripping a combination center drill and reamer. The front bearing of the spindle is made taper, after the well-known pattern of the Hendey-Norton lathe head, and the spindle is provided with a back locking pin for use when necessary to remove or replace the center drill.

The jaws of vise and supporting block are made of tool steel, hardened and ground, and aligned true from bar placed in the spindle of the machine. This care in alignment is exercised in order to enable the machine to accurately center stock for finishing purposes after coming from the turret lathe or screw machine. This was one of the active requirements of a centering machine as found in the every-day work of the shops.

The block and vise work in unison, controlled from the one ball handle, the two being kept in proper relation by means of the rod and spiral-geared drive located at back of the machine. This means that, no matter what diameter the bar may be within the limits of the machine, it will always be supported in a horizontal position, there being no hand adjustment and "eye alignment" necessary for back support, as usually required.

The inclined surface of the bed, sloping away from operator, tends to direct the chips into the pan, rather than have them accumulate around the head, necessitating frequent cleanings when it is desired to shift the carriage or saddle.

The heavy parallel bars, running the length of the machine serve the two-fold purpose of a rack for carrying stock to be centered, and, in connection with the inclined bed, prevent the common use of bed as a temporary support for the stock and the consequent bruising and banging of the bed which often throw the rear supporting block out of alignment.

The saddles are gibbed and fitted to bed, and provided with binding handles for ready clamping in position.

The machine is designed to handle stock from 5-16 inch to 3¼ inches inclusive. While many centering machines take up to 4 inches or even larger in diameter, the range of the machine is ample enough to cover all the needs of the larger portion of the centering work in the majority of shops, and will avoid the necessarily destructive influences exercised on any centering machine where they are called upon to handle bars weighing upward of 300 or 400 pounds each.

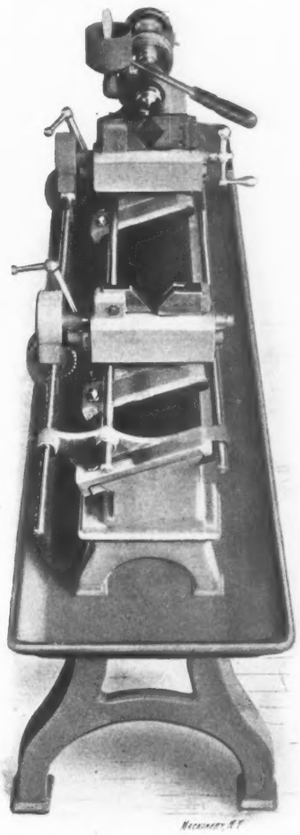


Fig. 2. View looking from Above.

The general dimensions of this machine are: Spindle bearing, front, taper, 1⅜ inch to 1 9-16 inch by 4¼ inches long; spindle bearing, rear, 1 3-16 inches by 3¼ inches long; length of bed, 4 feet 6 inches; greatest distance between vise and block, 34½ inches; capacity of vise, 5-16 inch to 3¼ inches; diameter friction pulley on countershaft, 10 inches; speed of countershaft, 300 R.P.M.; speed of machine, 1,000 R.P.M; floor space required, 69 inches by 21 inches; weight, net, 800 pounds.

QUICK CHANGE DEVICE FOR ENGINE LATHES.

The quick change device shown in Figs. 1 and 2, next page, for varying the feed, or lead of screws cut, has been adopted after a thorough test, by the New Haven Mfg. Co., New Haven, Conn., for its line of engine lathes of 32-inch swing and larger, and essentially in the same form for the lathes of 18-inch to 28-inch swing, with the exception that on the lathes below 32-inch swing it is given a wider range of change because of the additional changes provided at the end of the headstock.

The device includes a nest of seven bevel gears *L* mounted on the leadscrew shaft *P*. Above this nest of bevel gears is a bevel pinion *B* mounted on the quill *G* so that it can be moved longitudinally to permit of its being engaged with any one of the seven gears below it. The quill is splined to convey motion to the pinion *B*, and it is driven by the bevel pinion

F keyed on the end. *F*, in turn, receives its motion from the bevel pinion *E*, which is mounted on the change gear shaft and which carries at its outer end change gear *C*. The shaft *H* supporting the quill *G*, is mounted in two eccentrics *J J*, which give the bevel pinion *B* an in-and-out motion relative to the nest of gears when manipulated by the handle *K* for changing the gear ratio. The sliding pinion *B* is moved longitudinally to the position indicated by the index plate for the desired thread or feed, by means of the knob *M*, and after being engaged with the desired gear, is held in position by

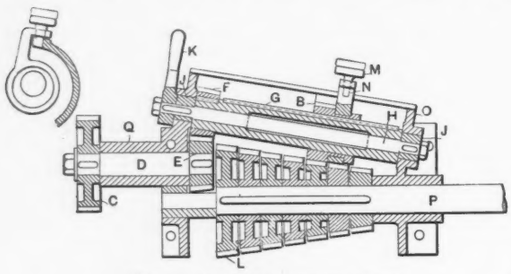


Fig. 1. SECTION THROUGH GEARS AND ECCENTRIC MECHANISM

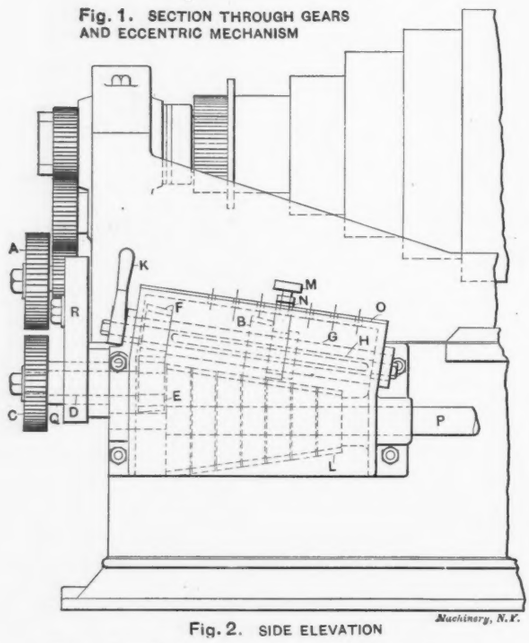


Fig. 2. SIDE ELEVATION

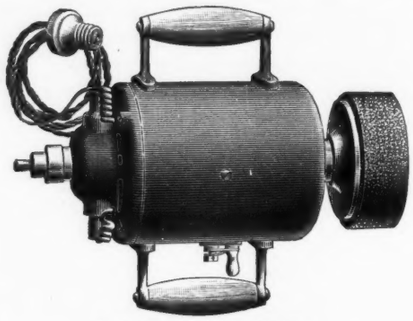
Change Gear Device of New Haven Mfg. Company.

the pin *N*. This pin enters a hole marked with the number of teeth of the gear with which the pinion is engaged, being, for instance, 48 in Fig. 2. This provides quick changes by steps between and including the ratio 32 to 56.

For wider ranges on the lathes of 32-inch swing and larger, a stud-plate *R* is mounted on the hub *Q* at the left end of the gear box *O* carrying gears so arranged that threads from 2 to 14 may be cut, or feeds from 8 to 56 obtained without changing the position of the intermediate stud, the gears being so proportioned that as one is removed from change gear shaft *E* it is used as the intermediate gear, and so on. Open washers are used on the ends of the studs so that no nuts have to be removed, thus making this portion of the change easily and quickly effected. On lathes of 18- to 28-inch swing, inclusive, four additional changes are provided. This is effected by adjusting gear *A* longitudinally, permitting it to be meshed with either of the intermediate gears, the intermediate gear in this case being compound; and by mounting two gears at *C* on the change gear shaft. These are of different diameters and both mesh with the compound intermediate gear. A sliding spring key is provided by which either gear can be thrown into clutch with the shaft, thus giving the four changes without changing gears, the stud-plate having to be shifted on its pivot for two of the changes. This gives a range from 1 to 15 threads per inch and feeds from 4 to 60 per inch inclusive. By changing gear *A* other changes, of course, are readily obtained.

PORTABLE ELECTRIC GRINDER.

The Hisey-Wolf Machine Co., Cincinnati, O., have added to their line of portable electric tools an electrically-driven hand buffer or grinder which is shown herewith. It is adapted for buffing, polishing, grinding, sanding or other work of this nature. It is light in weight and can be attached to any electric light socket with a cord of any length necessary to reach the

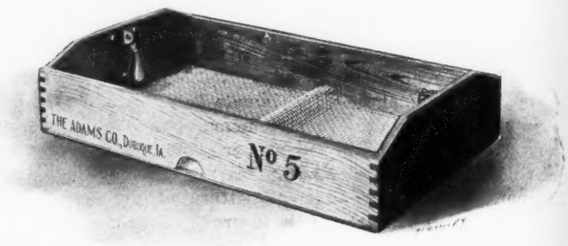


Portable Grinder and Buffer.

work. The motor is enclosed and dust-proof and the bearings are adjustable for wear. The motor is under the control of the operator at all times by a suitably located switch, and two handles are located diametrically opposite, enabling the operator to hold the grinder firmly and to manipulate it to advantage. Any kind of wheel can be attached for either buffing or grinding.

FOUNDRY RIDDLE.

A new riddle for molders' use has just been brought out by the Adams Company, Dubuque, Iowa, which is illustrated herewith. This was designed with two objects in view, i. e., to riddle all or very nearly all the sand into the flask (not half of it on the floor) hence the oblong shape; and to riddle the sand faster with less work. The latter end is gained by providing a small iron clapper on the inside of each end of the riddle in such a way that when the molder shakes the riddle back and forth, the clappers automatically vibrate or jar the



Riddle for Molders.

riddle. It is stated that the results are surprising. The riddle is well made and is very durable; the rapping of the clappers keeps the wire screen clean and the wire can be easily and quickly replaced when worn out. A raised rib in center of riddle serves to break up the large lumps of sand more quickly.

This riddle is made in one standard size, 11 x 18 inside, but other sizes can be made for special requirements.

LODGE & SHIPLEY HIGH-SPEED LATHE.

The Lodge & Shipley Machine Tool Co., Cincinnati, O., have produced a new type of lathe head, for use with high-speed steel, especially designed to stand the hard abuse to which such a machine is subjected. There is a single belt pulley attached to a sleeve through which the spindle passes. The hole through the sleeve is ⅛ inch larger in diameter than the outside diameter of the spindle, and it is supported entirely by two intermediate bearings placed between the spindle bearings, so that no belt strain whatever comes on the spindle. By this means it is possible to secure the necessary high speeds through the back gears without running the pulley on the spindle, thus eliminating a large part of the friction.

The end of the pulley sleeve has a positive clutch so that

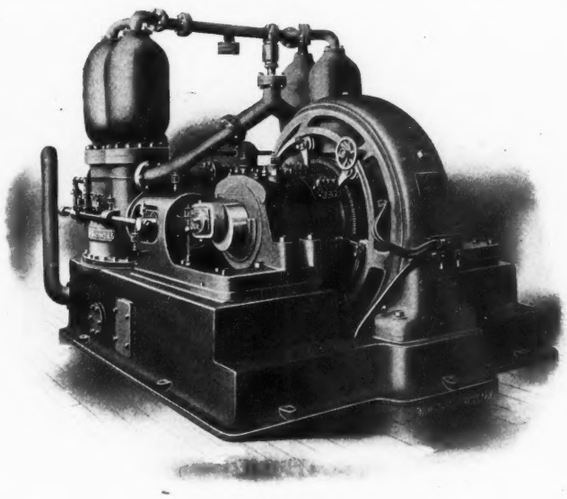
it can be engaged with a clutch which slides on the inside hub of the face gear. This clutch is operated by a lever handy to the operator. On the pulley sleeve are keyed two gears of different diameters into which either of a pair of sliding gears on the back gear shaft can be engaged. The ratios of these gears are: 3 to 1 and 9 to 1. The pulley on the sleeve is of large diameter and will take a much wider belt than formerly used on a cone pulley engine lathe. Special attention has been given to oiling, owing to the high speeds at which the lathe must run; deep oil wells are cast in the center of the bearings for the spindle and sleeve, which hold at least one pint of oil each. Ring oilers are used, but the rings have projections on them which scoop up the oil as they rotate. The other details of the lathe, aside from the head, are the same as those of the regular quick change gear lathe made by this company. The lathe is of 20-inch swing.

HIGH-SPEED ELECTRIC PUMP.

The operation of pumping machinery by electric motors, especially in mines, offers many obvious advantages, such as the centralization of the power plant, elasticity of extension of the system, high efficiency, small first cost and small expense for attendance.

Electric-driven pumps, however, have had one drawback, which, while not serious, had nevertheless to be taken into account. This was the necessity of toothed gearing, belts or other devices to transfer the power from the rapidly revolving motor shaft to the slow moving crank-shaft of the pump. Such devices added to the weight and size of the pumping unit and required either careful attention or frequent repairs. The use of toothed gearing on pumps in buildings is, moreover, objectionable on account of noise.

In the pump which we illustrate, the pump plungers are connected to cranks mounted directly upon the shaft of the



"Express" Electric Pump.

motor. This pump has a capacity of about 250 gallons per minute against 1,000 feet head when running at a speed of about 300 revolutions. The pump has been so proportioned, however, that its mechanical efficiency is over 93 per cent., approximating closely that of the highest types of large steam pumping engines. The pump is of the duplex type; the cranks at the opposite ends of the motor-shaft being set at right angles to each other. The plungers are of the outside-packed pattern and the two plungers of each pump are connected by side rods. The plungers are 3½ inches in diameter and have a stroke of 5½ inches. In a carefully conducted test, the pump proved a success in every way, surpassing the expectations of the purchasers and even of the builders, and its operation is practically noiseless.

The pump and motor are mounted upon a rigid box-girder frame and occupy a relatively small space. While high-speed pumps have been constructed before, they have usually had mechanically-operated valves, but the designers of this pump have eliminated such complicated mechanisms entirely, apparently with beneficial results. The pumps are built by the Blake and Knowles Steam Pump Works, 114 Liberty Street, New York City, in capacities of from 200 to 4,000 gallons per minute and for heads varying from 100 to 2,000 feet. A test of Blake-Knowles, high-speed, duplex pump, 3½-inch plungers, 5½-inch stroke, direct-connected to a General Electric, 100 horse power, six-pole, 200-volt shunt motor, gave the following results:

		Pump.			Efficiencies.		
Revolutions per Minute.	Motor Input, Watts.	Gallons Delivered.	Pressure, Pounds.	Pump H. P.	Motor Pump	Motor Alone	Pump Alone
280	28,800	237	110	32.63	78 p.c.	86.5 p.c.	90.1 p.c.
280	40,600	237	215	48.94	82.2 p.c.	89 p.c.	92.36 p.c.
280	52,550	235	321	62.25	84.4 p.c.	90.1 p.c.	93.66 p.c.
280	60,200	234	425	74.53	84.3 p.c.	90.9 p.c.	92.74 p.c.
309	58,800	232	496	71.79	83.3 p.c.	.....	.....

OWEN MILLING MACHINE.

A new positive feed milling machine of the knee type has been placed on the market by the Owen Machine Tool Co., Springfield, O., and is here illustrated with two photographic views and a line drawing. The general specifications of the machine are as follows: The spindle is of crucible steel running in phosphor bronze boxes, and throughout the machine the plan has been followed of bushing the bearings for the various shafts and other rotating parts with bronze bushings, which insures durable wearing surfaces that may easily be replaced if occasion should require. The cone has four steps for a 3-inch belt, and with back gears which are covered; the machine has eight changes of speed. The overhang of the arm is 4 inches in diameter. The table has a working surface of 41 by 9¼ inches and can be lowered 17½ inches

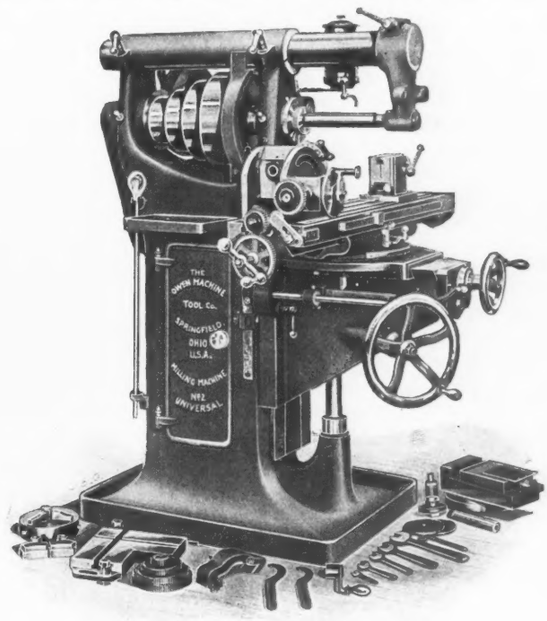


Fig. 1. Owen Milling Machine.

from the center of the spindle. The feed of the table is 25 inches and is positive and automatic. It can be engaged by simple movement of lever in front of swivel and can be disengaged by auxiliary lever releasing any feed instantly. The swivel can be clamped at any angle to 45 degrees. Sixteen changes of feed in geometrical progression vary from .003 inch to .084 inch per revolution of spindle back gear out; .020 inch to .500 inch back gear in. The absolute feeds per minute, countershaft running at 150 revolutions, are from 5/8 inch to 10¼ inches.

The details of the feed mechanism are shown in Fig. 3. The mechanism is driven by a chain and sprockets from the end of the milling machine spindle. Power is transmitted to shaft *B*, which, at one end, has the back gears *A* that may be thrown in or out of connection with shaft *B* by means of a handle convenient to the operator. These gears may be used

either to change from a slow to a rapid feed, or *vice versa*; or they may be used to keep the feed constant, when the speed of the milling machine spindle is changed, by means of the main back gears. The feed back gears give the same ratio of reduction as the main back gears in order to accomplish this result.

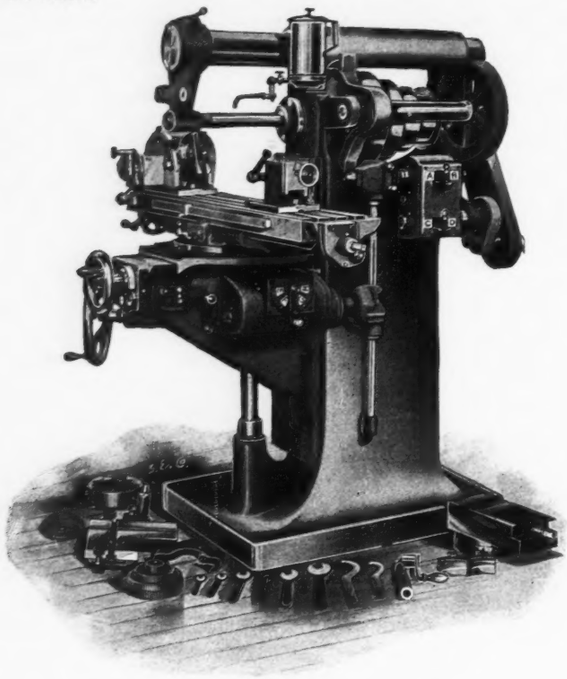


Fig. 2.

clutches shown, either train of gears may be used which gives two feed changes.

The reversal of the feed is accomplished by the bevel gears and connecting clutch shown at *E*.

Power is transmitted to the feed box attached to the knee of the machine by the vertical splined shaft *F* and the bevel gears *G*, Fig. 3. These gears drive the horizontal shaft *H* on which is a clutch (containing new features of construction) which connects this shaft with any one of four trains of gears, giving at this point four changes of feeds. The clutch is operated by a handle attached to pinion *P* which gears with rack *R*. At the right will be noted pinion 10, attached to a sleeve which, at its left-hand end, has clutch teeth marked *d*. This pinion gears with pinion 11 and gives one speed. Pinion 8 has another set of clutch teeth marked *c*, and this pinion gears with pinion 9 and gives another speed change. The shifting part of the clutch contains teeth marked *a a*, which will mesh with the teeth *c* mentioned above by sliding the clutch to the right. By giving the clutch additional movement to the right, however, teeth *a* will travel by teeth *c* and allow the teeth marked *b*, on the extreme end of the clutch sleeve, to mesh with teeth *d* on pinion 10. At the other end of the clutch are similar arrangements for the two sets of gears shown.

This feed box, in connection with the other one, will give sixteen changes. The feed changes are all within easy reach of the operator and can be engaged when the machine is in motion without injury to the working parts, inasmuch as the clutches and pinions are of steel. The feeds are in geometrical progression.

WALKER UNIVERSAL GRINDING MACHINE.

The latest machine of the Walker Grinder Company, Worcester, Mass., is shown in the accompanying illustrations. It

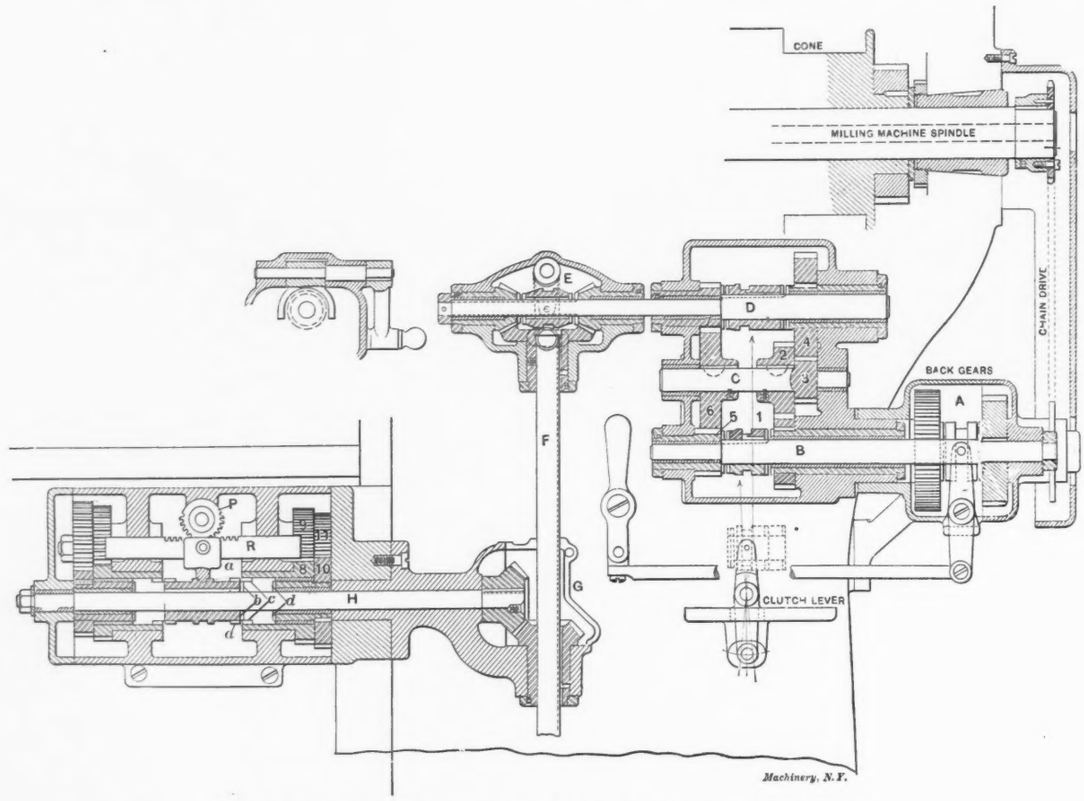


Fig. 3. Details of Feed Mechanism of Owen Machine Tool Company's Milling Machine.

Motion is transmitted from shaft *B* to the milling machine table through two feed boxes, one of which is near the top of the base of the machine, as shown in Fig. 2, and the other attached to the knee. The first box contains shafts *C* and *D*, in addition to shaft *B* and two trains of gears which are numbered respectively 1 2 3 4 and 5 6 7. By means of the two

is a universal grinder, a comparatively light machine but of large capacity. It is designed primarily as a cutter grinder but can be used for miscellaneous grinding of all sorts of work, and with its various attachments it is believed by the manufacturers to be more completely universal in its scope than any grinder heretofore produced.

The fundamental principle of the machine is to start with a grinder primarily of the universal type and then to add such attachments as to adapt it to practically every kind of light grinding. The distinctive feature is that these attachments are extremely simple and fewer in number than are usually supplied with ordinary cutter and reamer grinders; and yet they are of such a nature that an unusual variety of work can be accomplished.

First in importance is the design of the head carrying the wheel spindle. This is shown in detail in Fig. 2. The head is supported by a sliding post, *A*, which can be raised and lowered by a screw, *B*. The wheel arbor is supported by a swiveling head, *C*, at the top of the column, and the arbor is belt-driven by the patented Walker system, which enables the head to be adjusted in any position up or down, or at any angle, without shifting the belt or without requiring any adjustment in the tension of the belt. The belt passes successively around pulleys *a*, *b*, *c*, and *d*; whence it goes up to the countershaft pulley. It will readily be seen that this arrangement allows a universal adjustment of the head without interfering with the belt drive.

It is a well-known principle that in taper grinding the contact point of the wheel must be in line with the axis of the work. The reading line *x*, therefore, is marked on the adjusting post of the head which, when set to coincide with the top of the housing, will bring the head and tail centers and wheel axis in the same horizontal plane. Another line marked *y*, Fig. 2, indicates the average height to raise the column in order to back off the teeth of cutters that are being ground. The tooth rest, *D*, Fig. 2, is clamped to the column, and is of

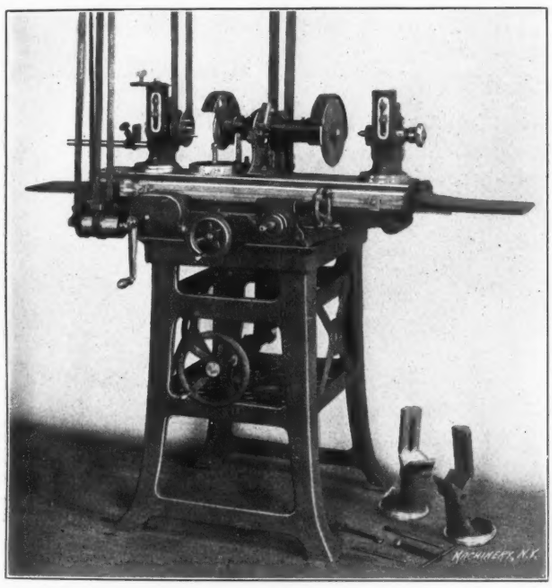


Fig. 1. Walker Universal Grinder.

such a height that when set so as to just rest on top of the grinder table its height will coincide with the line of centers. It is therefore extremely simple of adjustment. It is obvious that the tooth rest can be swung into any position to accommodate angular work.

The second most important feature of the machine is the use of so-called V-heads, shown in Fig. 3. Lugs, *N N*, serve to locate the heads in the T-slots of the table, and they are clamped in position by the nut *L* and bolt *M*, which is inclined so as to draw the head solidly against one side of the T-slot. When it is desired to swivel one of the heads it is placed on a graduated pedestal, not shown, and the bolt is changed to a vertical position. These heads are finished with accurately aligned V-grooves, in which may be clamped any cylindrical or, in fact, other shaped piece. The arrangement of the clamping device is evident from the sketch which shows how it can be used to hold taper pieces.

The first illustration shows the V-heads fitted with live and dead centers. These centers are simply fitted up in cylindrical bushings of a uniform outside diameter, and the bushings are clamped in the V-grooves. Fig. 4 shows the centers removed and a milling cutter arbor held in their place while the cutter is being ground. It indicates that the length of work held in this way is not restricted by the distance between centers.

In Fig. 5 is shown an end mill held in one of these heads by its taper shank, and it is to be noted that the clearance for

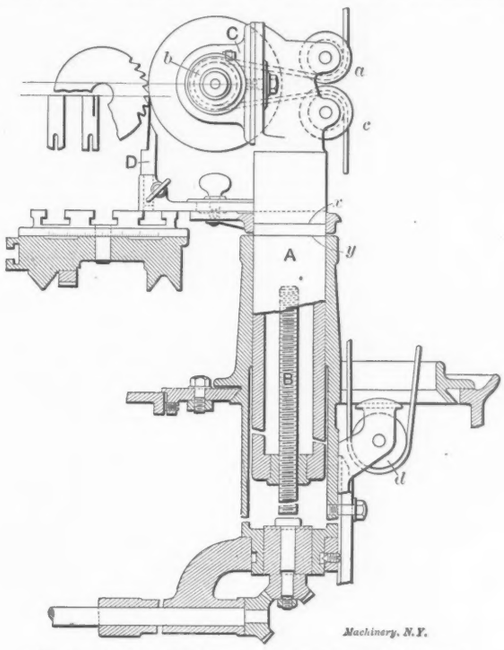


Fig. 2. Details of Column for Supporting Wheel Stand.

the cutters is obtained by tilting the wheel arbor. This also shows a tooth rest clamped to the top of the head and also the back stop, against which the cutter arbor rests.

The illustrations thus far which show the universal features of the wheel head and the V-heads, will indicate to the mechanic how the wheel and the work may be brought into almost any relative position so that work of almost any shape can readily be ground, whether clearance is required or not. A very important feature of the swiveling wheel head is that it can be tilted to allow a thin beveled wheel to be used for grinding hand reamers without materially changing the size of the reamers. This is accomplished by grinding on the face of the teeth instead of on the outside diameter of the reamer.

Fig. 6 illustrates one of the uses of the universal chuck and independent spindle here shown, in place of the regular head center and faceplate, for holding a piece of work that cannot be centered in any other way. The independent spindle sleeve

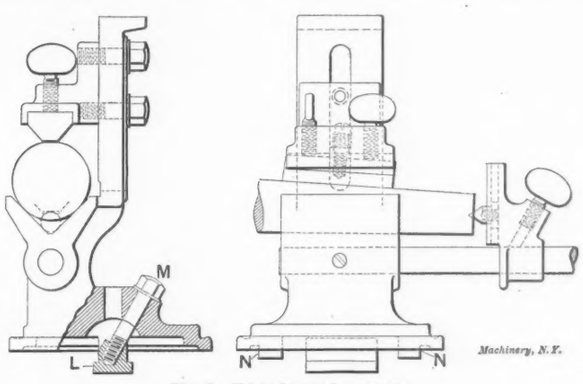


Fig 3. V-heads used on Table

and the tail spindle sleeve being of exactly the same diameter the work is held in perfect alignment. In Fig. 7 the wheel arbor is swung around through an angle of 90 degrees and fitted with a lap for finishing a snap gage held by one of the V-heads. Fig. 8 is an example of face grinding where the cutter is supported by a draw-back face chuck, and Fig. 9 is an interesting view of grinding a vertical flat surface where it is desired also to get down into a corner. This is

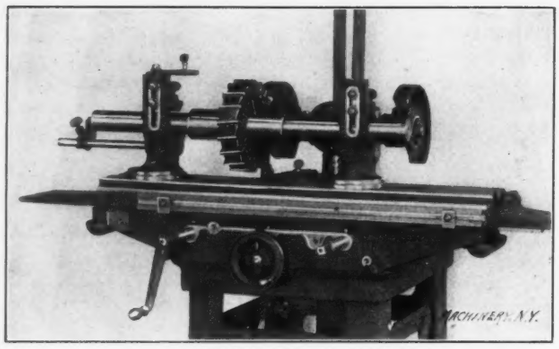


Fig. 4.

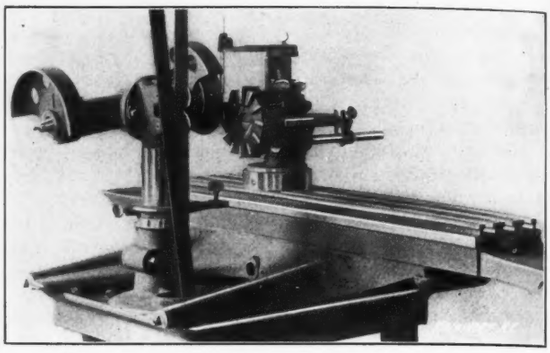


Fig. 5.

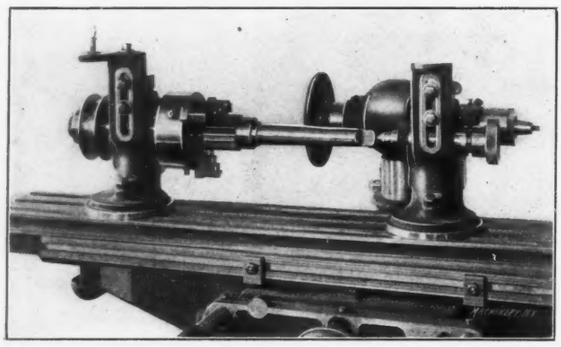


Fig. 6.

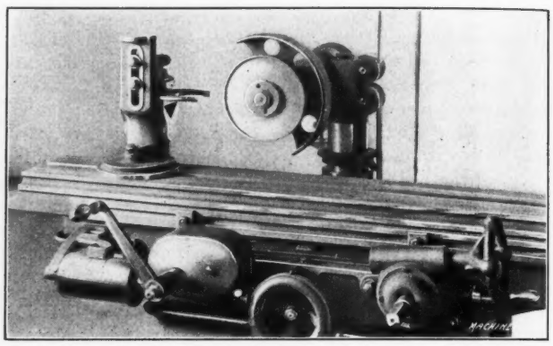


Fig. 7.

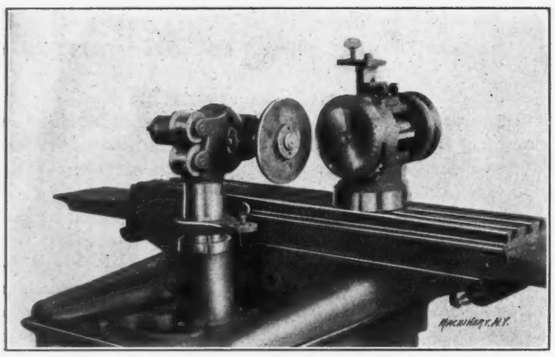


Fig. 8.

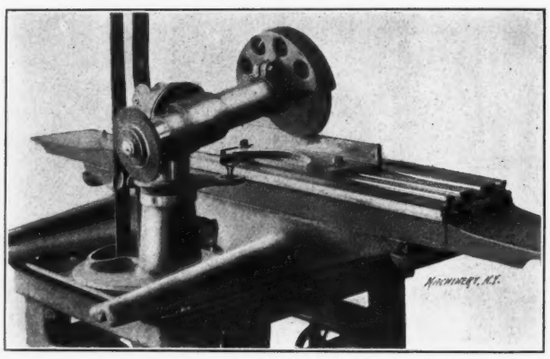


Fig. 9.

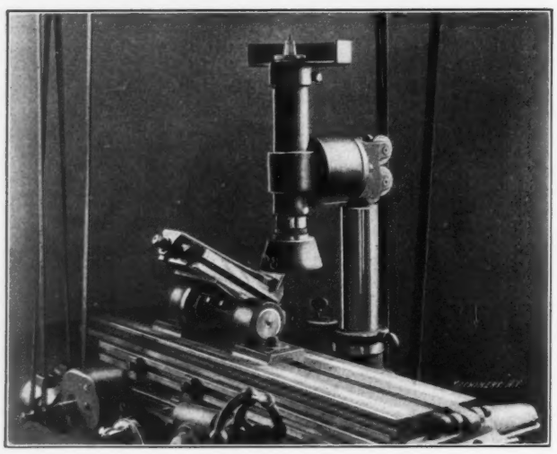


Fig. 10.

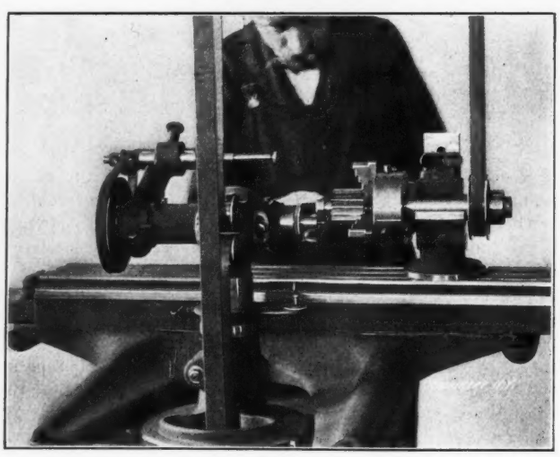


Fig. 11.

readily accomplished by tilting the wheel head slightly. Fig. 10 illustrates the extreme vertical adjustment of the grinding spindle, it being necessary in this case to insert an extension sleeve between the head and the post to obtain sufficient overhang for using the cupped emery wheel. This also shows the tilting vise fitted to the machine.

Fig. 11 illustrates the internal grinding fixture and one of its uses. This attachment fits on one end of the wheel head, on which it swivels, and is belt-driven. The small arbor is supported by a telescopic arm, and the central position of the small arbor is determined by a positive stop on the grinder head.

Perhaps as difficult a problem as any connected with the design of a universal grinder is the question of variable speeds. In this grinder special attention has been paid to the countershaft and a moderate-priced countershaft has been provided as the basis to which variable-speed devices can be attached at any time by the changing of a few parts. The principle of the variable-speed device is shown in the detail

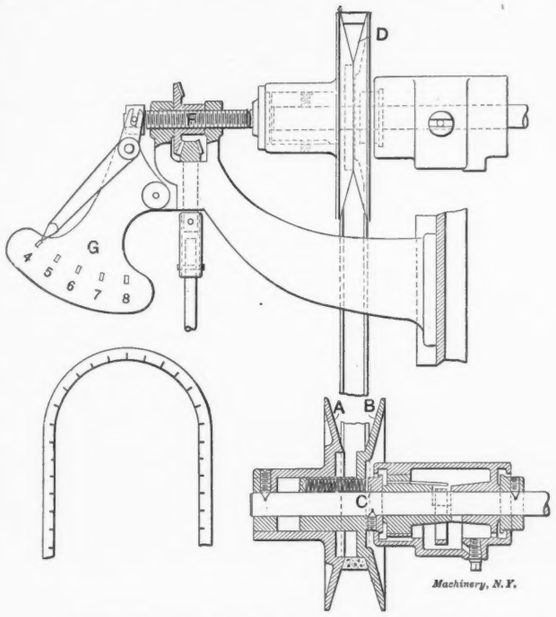
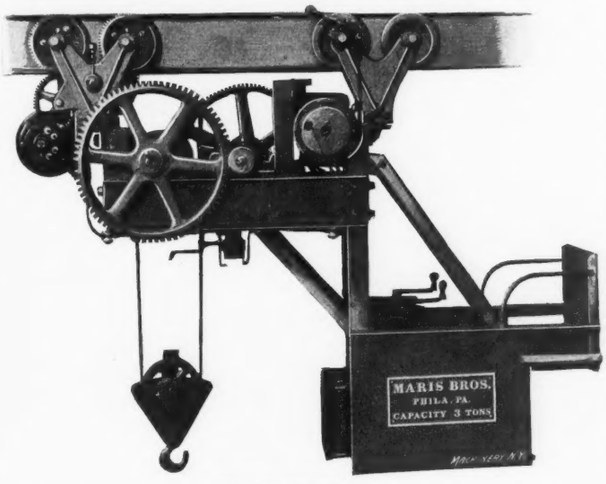


Fig. 12. Variable Speed Mechanism of Countershaft

sketch, Fig. 12. Here the disks *A* and *B* are forced together by coil springs abutting on a collar *C*, which is fast to the shaft. This provides automatic action of these disks on the beveled edge belt, and it will be noticed that when the upper disks, at *D*, are closed, disks *A* and *B* will be forced open, and *vice versa*. The upper disks are mechanically operated by means of the pendant rod through bevel gears, and the horizontal screw *F*. When this screw is slackened the left-hand

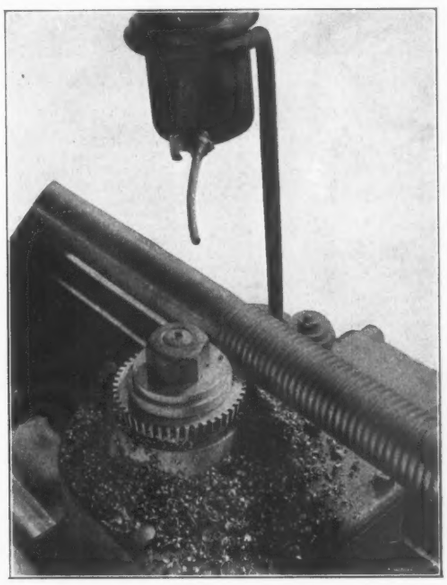


Maris Traveling Hoist.

disk will move to the left, as will also the lower disk *B*, due to the action of its spring. This maintains the belt always in alignment but it will alternately approach and recede from the centers of the two shafts, and thus vary the speed of the driven one. The upper shaft is provided with an index dial *G*, indicating the proper size of grinding wheel to use for a given speed.

MARIS TRAVELING HOIST.

Maris Bros., Philadelphia, Pa., have brought out the new electric traveling hoist here shown, for rapid and therefore economical handling of materials. The half-tone shows this machine designed to run on the lower flange of I-beam track and having a cage for the operator. The whole machine is very compact, as shown by the following over-all dimensions of the three-ton size. Width 2 feet 7 inches, length 8 feet 4 inches, height bottom of track to bottom of cage 5 feet 1¼ inch, bottom of track to hook at highest point 3 feet 5 inches. The trucks are built either with swivel for curved track, or rigid for straight track. In cases where these machines have to cross switches or breaks in the tracks, as in transferring from a crane to a side run, there is an additional set of electrical contacts provided so as to avoid any dead point in running from one wire to the other. The hoist is by means of spur gears and wire rope, overrunning being prevented by an automatic cut-out. The cut-out only allows the block to travel



Newton Screw Thread Generating Machine

to a set height when the switch is thrown and current reversed, allowing the load to be lowered, but not causing it to be hoisted until the switch is again set by the operator. No time is lost in depositing a load and there is no danger of overrunning on the hoist. The switch is in easy reach of the operator in the cage.

The cut-out is operated by the block in contact with a lever, and not by a screw or gears. This block-operated feature is important, as no matter how much the load rope may stretch or be shortened or lengthened with reference to the hoist, it will always throw the switch when the block is a fixed distance from the highest point.

These machines are made in various sizes and styles, to operate from a cage or from the floor.

NEWTON SCREW THREAD GENERATING MACHINE.

A tool has been designed by the Newton Machine Tool Works, Philadelphia, Pa., for generating and cutting screw threads. The cutting head of the machine is illustrated in the half-tone from the photograph shown herewith. The tool is in the form of a gear wheel having teeth of the proper shape to generate threads of the proper section in the screw to be cut. The teeth of the gear wheel are backed off and have clearance, to give cutting edges.

The tool revolves in a given proportion to the thread to be generated, and is geared to the correct relation to the lead of the thread being generated, and can be used for generating a thread of any pitch or number of leads with the exception of a square thread, which cannot be cut on this machine. The shaft on which the thread is to be generated, is driven at the ordinary cutting speed for this work, and the cutter is adjusted to take the full depth of thread in one cut.

The spindle to which the cutter is keyed obtains its rotative movement through a worm and wormwheel, which gives a smooth action to the cutter by change gearing.

This tool is not as yet perfected, but the screws that have

been generated on this machine, have shown a remarkable saving in time, together with an exceptionally good screw or thread. The chips shown on the cutter head will give some idea of how the tool cuts.

* * *

It is sometimes found to be quite a convenience to have the bed of an engine lathe graduated in inches for quick setting of the tailstock. The graduations should be made with average length of centers in place and with the tailstock spindle drawn clear back into the tailstock. When a lathe is so marked a job can be measured on the floor and the tailstock set for it before lifting it into the machine.

* * *

FRESH FROM THE PRESS.

AN ENGINEERING STUDENT'S NOTES, by J. Richards. 201 pages, 5½ x 7½ inches. No illustrations. Published by the Industrial Publishing Company, San Francisco, Cal. Price, $1.00.

This little book is not a collection of formulas and engineering data, in the usual sense of the terms, but is a series of notes and comments on things mechanical and otherwise, made by one who has traveled much and who sees things and thinks about them. Mr. Richards is the author of the "Notes from a Roving Contributor," published in MACHINERY a few years ago, and those readers who were fortunate enough to have read these delightful "thinks" will have some idea of what the present volume contains. For instance, the well-known Laxa waterwheel used for mine pumping on the Isle of Man, which was visited years ago by Mr. Richards as a technology student, traveling with his uncle, comes in for comment like this: "Just here is a chance for some mechanical moralizing. Suppose that wheel, instead of being constructed with arms and tie-rods as light as a bicycle, had been a heavy, cumbrous affair of the utilitarian kind, and had been set down in a pit in the usual manner with an old box penstock and chute; half the cost would have been saved, and what of that? No one would ever have gone to see the wheel. The cab fares extracted from affluent travelers will each year fully pay the difference, and as a large share of the community consider money thus earned a gain of wealth, it is more, much more, legitimate and consistent than selling Pear's soap, and much else that is invented to play on human credulity, and extract shekels from the unwary."

A NEW DIRECTORY OF MACHINERY MANUFACTURERS.

THE MECHANICAL INDEX. Over 1,000 pages, 6 x 8½ inches, bound in red cloth. Published by the INDUSTRIAL PRESS, 66 West Broadway, New York.

The purchasing and selling departments of manufacturing concerns will be interested in THE MECHANICAL INDEX, which, as its title indicates, is a complete directory of all manufacturers in the United States of mechanical tools and appliances, operated by steam, electricity, water, air, hand or foot power. An extremely valuable feature of the work is the completeness of its classification, there being in all over two thousand five hundred different classifications, covering every kind of machine tool, metal-working machinery, wood-working machinery, electrical appliance, steam appliance, railway appliance, agricultural machinery, textile machinery, mining machinery, hoisting and conveying machinery, foundry equipment, and a hundred other classes of mechanical appliances. The thoroughness of its classification is further indicated by the fact that there are thirty-eight different sub-headings for metal-working lathes alone. Each of these subheadings is defined and carries an alphabetical list of manufacturers of that special kind of appliance. We consider it the most complete index to the machinery trades published, and it will prove a standard work of reference of great practical value to all manufacturers doing business with the trades covered.

NEW TRADE LITERATURE.

Manufacturers and others sending catalogues for notice are requested to address them to the Editor of MACHINERY, so that they can be kept separate from catalogues sent us for other purposes.

THE F. BISSELL CO., Toledo, O., manufacturers and jobbers of electrical supplies, are distributing their new Bulletin M29 on electrical measuring instruments.

THE LINK-BELT ENGINEERING CO., Philadelphia, Pa. Booklet No. 39, 1904, describing the "Renold" silent chain gear for the smooth and noiseless driving of machinery.

THE NATIONAL ELECTRIC CO., Milwaukee, Wis. Bulletin No. 350 of stationary and portable motor-driven air compressors. Types "H" and "L" are here shown and described.

THE O. K. TOOL HOLDER CO., Shelton, Conn. Pamphlet treating of the O. K. patent tool holder, with assorted tools and fixtures. This holder was fully described in our last issue.

THE STAR CORUNDUM WHEEL CO., LTD., Detroit, Mich. Pamphlet calling attention to the "Star" emery and corundum wheels. These are made of different degrees of hardness for the various classes of work.

THE D. M. STEWARD MFG. CO., Chattanooga, Tenn. Leaflets pertaining to the "Compo" crayons of their manufacture, made especially for marking freight cars, car trucks, etc., in a distinct and legible manner.

THE NORTHERN ELECTRICAL MFG. CO., Madison, Wis. Leaflets Nos. 130 and 133 calling attention to the "Northern" motor for electric drive. These are shown driving a buzz saw, a swing cut-off saw, operating hoists and racks, etc.

THE PIKE MFG. CO., Pike, N. H. Illustrated pocket catalogue of the oil stones manufactured. This is an interesting pamphlet; besides illustrations of the various kinds of oil stone, some useful instructions concerning their care and use, etc., appear.

WICKES BROS., 113-115 Cedar Street, New York. Leaflet illustrating the Wolverine center crank engine, the Wolverine plain and automatic vertical engine, and a plain vertical boiler and locomotive portable boiler of their manufacture.

THE NATIONAL-ACME MFG. CO., Cleveland, O. Folder illustrating the "Acme Automatic" multiple spindle screw machine. This at present is built in six sizes, and two additional sizes—the No. 0, the smallest, and No. 6, the largest—will soon be ready.

THE GOLDSCHMIDT THERMIT CO., Wall Street Exchange Building, New York. Folder relative to "thermit" for welding iron and steel of any section, trolley rails, girders, shafts, sternposts, etc. An article on "thermit" and its uses was published in the March, 1903, issue of MACHINERY.

THE GARVIN MACHINE CO., New York. Catalogue "G" of metal working machine tools. This book presents the agency goods carried in stock by the company, contains 274 pages, and illustrates drill presses, engine lathes, planers, shapers, punch presses and shears, and grinding and polishing machinery.

THE THOS. H. DALLETT CO., Philadelphia, Pa. Illustrated catalogue of portable drilling machines and boiler shell drills. These drilling machines, which are built in various sizes, are here fully illustrated and described and specifications given. A few hand drills and a pneumatic hose coupling are also shown.

THE CARLYLE JOHNSON MACHINE CO., Hartford, Conn. Pamphlet descriptive of the Johnson friction clutches for countershafts, also for use with line shafts—saving power, belting and pulleys. This clutch is simple in construction and smooth running, and the working parts are entirely covered, being thus kept free from dirt.

THE NILES-BEMENT-POND CO., New York. July, 1904, number of the *Progress Reporter*, to be issued every few weeks with a view to keep readers informed as to the new machines and devices which they are bringing out. This number contains illustrations of the heavy machine tools built by the several firms constituting this company.

THE HISEY-WOLF MACHINE CO., Cincinnati, O. 1904 catalogue of the "Hisey" portable electrically-driven grinders and drills. The different types of these machines are here shown and described and illustrations of the uses to which they can be put are given. A list of the users of these tools also appears, among which we note the names of prominent manufacturers.

THE HOGGSON & PETTIS MFG. CO., New Haven, Conn. Catalogue 7 illustrating the "Sweetland" chuck. The "Sweetland" combination, universal, independent, and geared scroll chucks are here shown in different styles. Special chucks for various lines of work are also made. The "Porter" belt tightener, for clamping together securely the ends of large belts is also shown.

THE B. F. BARNES CO., Rockford, Ill. Illustrated catalogue, 1904, of machine tools. These include upright drills, lathes, water tool grinders, etc. The different sizes of drills are shown, in particular a battery of six 20-inch drills, two new sliding head drills, various sizes of gang drills and the two-spindle manufacturers' drill with automatic revolving chuck, described in our July number.

THE MASSACHUSETTS TOOL CO., Greenfield, Mass. No. 4 catalogue of precision tools. This illustrates and briefly describes calipers, dividers, gages, drill and reamer holders, micrometers, levels, protractors, etc.—in fact all those tools necessary to the machinist engaged in fine and accurate work. This catalogue supersedes all previous editions and contains quite a number of new tools and devices.

THE CLEVELAND TWIST DRILL CO., Cleveland, O. 1904 catalogue, superseding all previous editions. This catalogue illustrates the twist drills, reamers, taps, mills, cutters, etc., manufactured, and a very complete index appears; also some valuable tables and other information on the subject of drills, etc. They call special attention to their turret lathe and screw machine tools, pages 72 to 74. A copy of this catalogue will be mailed to any one interested, upon request.

HENRY R. WORTHINGTON, New York. Catalogue W-50 of Worthington centrifugal pumps. These are of the turbine, volute and conoidal types. Each of these types is here described and illustrated, the different sizes of each being shown. These pumps may be driven by electric motor power. The front page of the catalogue shows a view of the new works of the company, containing 18 acres of floor space, and being erected at Harrison, N. J.

THE INGERSOLL-SERGEANT DRILL CO., 26 Cortlandt St., New York. Catalogue No. 35, of air compressors. This is simply the "Advance Sheets" of their catalogue No. 36 now in course of preparation, but it illustrates the different standard types and sizes of air compressors manufactured, and is complete in itself. The company state that their aim has been to present cuts of the standard types and prominent installations, with comments upon each, brief and to the point. The half-tone reproductions and press work are very fine, and there is a good view of their new works at Phillipsburg, N. J.

THE INGERSOLL-SERGEANT DRILL CO., New York. Attractive pamphlet issued by the pneumatic tool department of this company, containing a full description and excellent illustrations of the construction of the Haeseler "Axial Valve" hammer. Reference is also made as to the scope of a recent decision of the Supreme Court bearing on patented features of pneumatic hammer handles. These hammers are for chipping, calking, flue-beading, riveting, etc., and are manufactured in a variety of sizes. The MacDonald rivet heating forge, and piston drills, yoke and jam riveters and other tools are also shown here.

THE GARRY IRON AND STEEL CO., Cleveland, O., report the following orders: One three-motor special electric Gantry transfer crane, of entirely new design, for the Raritan Copper Works, Perth Amboy; one of their latest improved three-ton pneumatic pit jacks, for the Indianapolis & Cincinnati Traction Co.; the automatic pneumatic mechanism for operating models of Climax and Tower couplers at the exhibit of the National Malleable Casting Co. at St. Louis, also an automatic pneumatic turntable for the same company; one four-hook overhead crane for the Western Electric Co.; one two-part clam-shell bucket for the Lake Sand and Gravel Co., etc.

MANUFACTURERS' NOTES.

THE CINCINNATI MILLING MACHINE CO., Cincinnati, O., have received the order of the Canadian Westinghouse Electric & Mfg. Co., Hamilton, Ontario, Canada, for eleven milling machines and two cutter grinders.

THE CROCKER-WHEELER CO., Ampere, N. J., announce that they have taken steps to give their clients expert advice upon the latest ideas and results in shop practice, also engineering advice upon the design and installation of electrical apparatus. For this purpose they have retained the firm of Dodge & Day, Philadelphia, modernizing engineers.

THE COLUMBUS MACHINE CO., Columbus, O., have opened an office in Cincinnati, O., at 227 West Fifth Street, where they will carry a stock of engines. The office will be in charge of Mr. Van Dusen, who is well-known to the gasoline engine trade. Mr. Van Dusen will be pleased to receive his old customers and friends, and any prospective buyers of gas engines, as he will have engines in operation to show the merits of the Columbus.

THE NORTHERN ELECTRICAL MFG. CO., Madison, Wis., have called our attention to the fact that three of the new tools which we illustrated in our July number are operated with the "Northern" single voltage variable-speed motor. These are the Gisholt boring mill, the National Machinery Co.'s bolt cutter and the Merrell pipe cutting machine, all described in the "New Tools of the Month" department of the above-named issue.

REYNOLDS & GORDON is the name of a new firm just started in Brooklyn, N. Y., corner Vanderbilt and East Third Streets. Mr. J. R. Gordon, of the firm, has had an extended experience in fine tool work and has been a frequent and valued contributor to MACHINERY upon tool making. The work of the new firm is to be largely in the direction of fine tool, die and machine work, and attention will also be given to the development of inventions, the making of models, etc.

AUGUST MIETZ, New York, manufacturer of the Mietz & Weiss oil and gas engine, has recently installed a 10-horse power "M. & W." engine air compressor in the new building at 42d Street and Park avenue, this city, now in course of construction. The air compressor is an 8 x 8, giving 70 cubic feet of free air per minute against 80 pounds pressure. It was installed by Ritchie, Brown & Donnelly, contractors, to furnish air for their pneumatic tools.

THE CROCKER-WHEELER CO., Ampere, N. J., announce that by arrangement with Brown, Boveri & Co., Switzerland, electrical engineers, they have secured their alternating current designs, patents and rights

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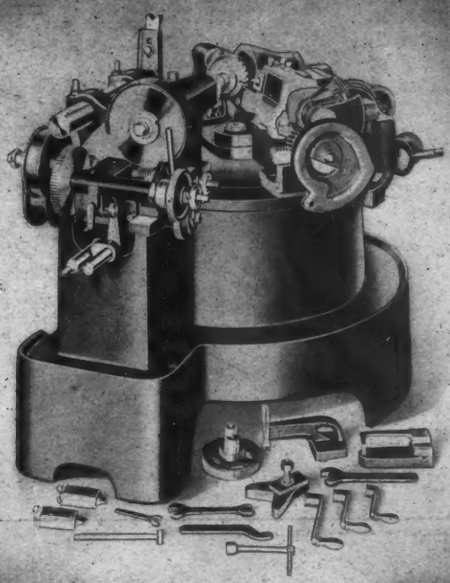

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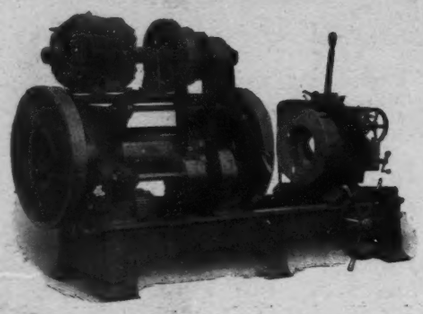

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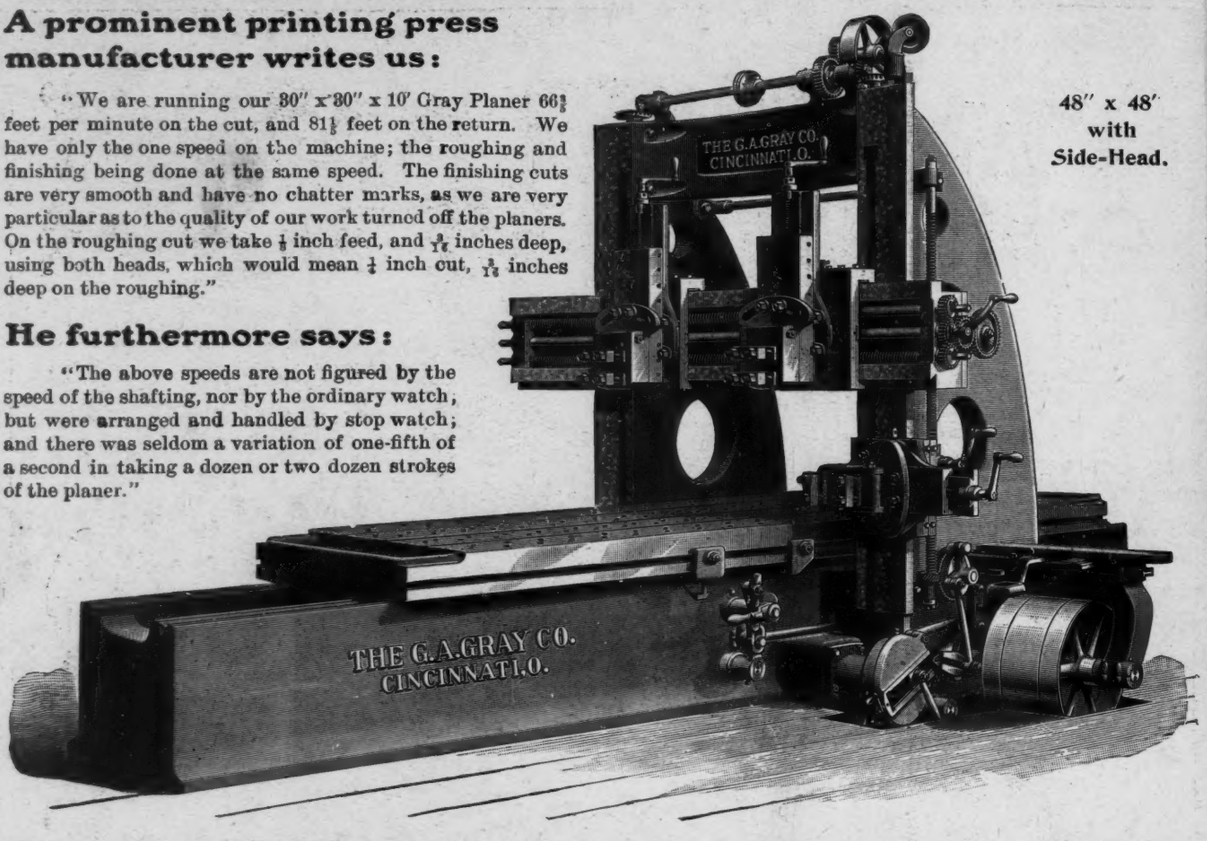

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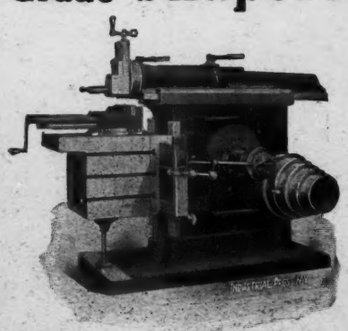

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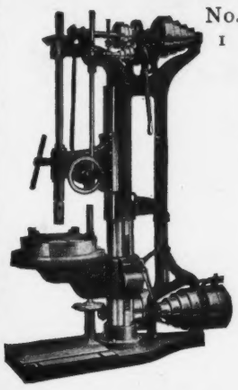

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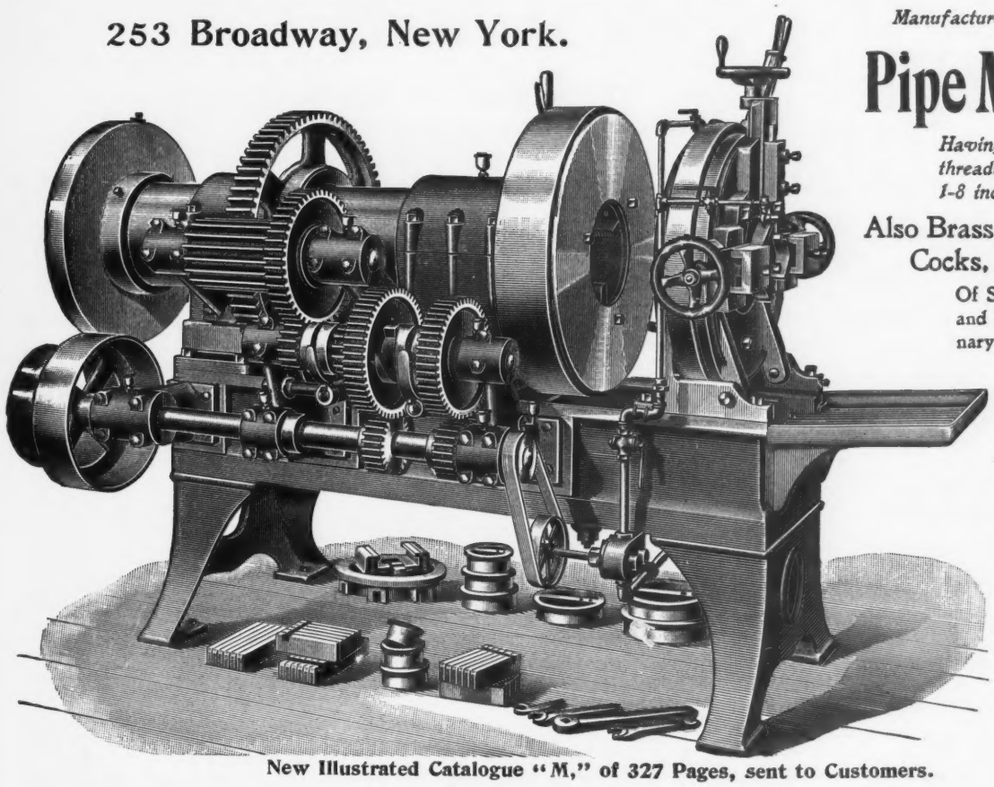

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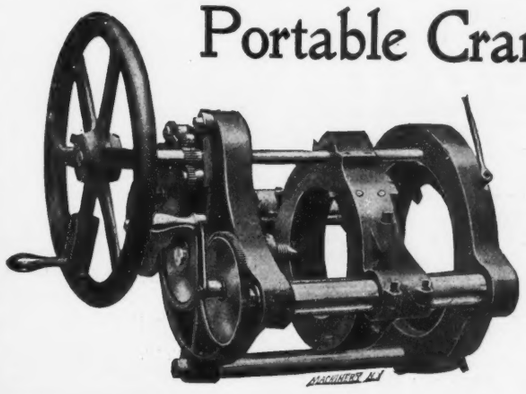
New Illustrated Catalogue "M," of 327 Pages, sent to Customers.

Portable Crank-pin Turning Machine



This tool is vastly superior to the older style machines used for the purpose, and is specially designed for overcoming the difficulties of returning large crank-pins. It is light in weight, strong and durable; arranged to feed either way and will do its work quickly and accurately.

Send for Catalogue describing this and other tools.

(L. B. Flanders Machine Works)

H. B. Underwood & Company,

1025 Hamilton Street, Philadelphia, Pa.

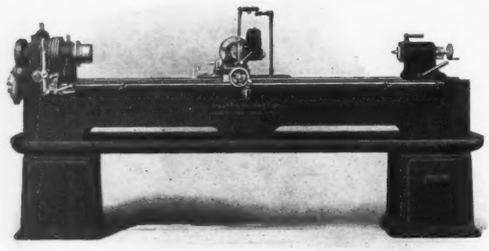
DANIEL W. PEDRICK. MORRIS G. CONDON. ALBERT D. PEDRICK.

P. & W. Thread

Milling Machines

FIVE SIZES

6 x 14 in., 6 x 48 in., 6 x 80 in., 6 x 132 in., 12 x 48 in.



Thread Milling Machine, 6-in. swing, 80-in. between centers

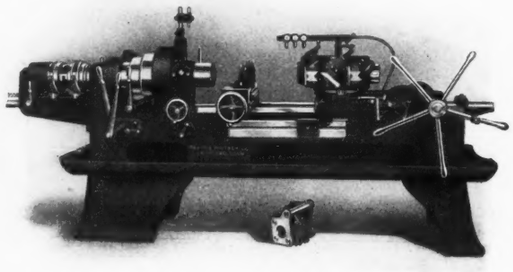
The milling machine, not the lathe, the modern way to cut threads and worms. Greater accuracy, capacity and convenience at a saving of from a half to a fifth of the cost.

New Model

Turret Lathes

FIVE SIZES

5-8 x 4 1-2 in., 1 x 10 in., 1 1-2 x 18 in., 2 x 26 in., 3 x 36 in.



3x36-inch New Model Turret Lathe

The most powerful, rapid and accurate machines on the market for rod work up to three inches in diameter. **The only machine capable of using rough stock.**

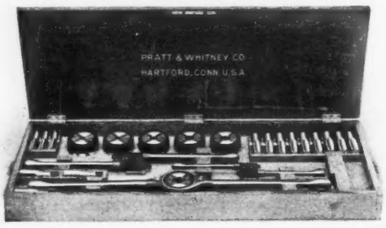
Visit our exhibit at the World's Fair, Blocks 17 and 25, Palace of Machinery.

SMALL TOOL DEPARTMENT

TAPS—Our special process taps are made uniform, and have one-third longer life than any other made.

REAMERS—Eccentric ground reamers give a smooth glass surface, and will not chatter, because the cutting edge is supported.

RATCHET DRILLS—The Renshaw ratchet is the lightest and strongest made; each part of drop forged steel; feed automatic.



MILLING CUTTERS—All sizes, kind and shapes; standard and special.

PUNCHES AND DIES—Spiral punches are easy on the plate, and on the machine. All sizes in stock.

ECHOLS' PATENT TAPS—The interrupted thread tap is the only one for tough steel, copper, etc. Clears itself where others clog and wedge.

GAUGES—Plug, ring, caliper and thread gauges, of the highest quality obtainable.

SEND FOR SMALL TOOL CATALOGUE.

PRATT & WHITNEY CO.

136-138 Liberty St., New York. **Works, Hartford, Connecticut.**

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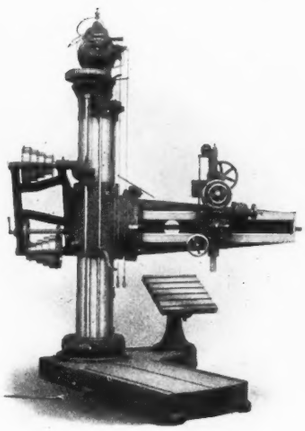
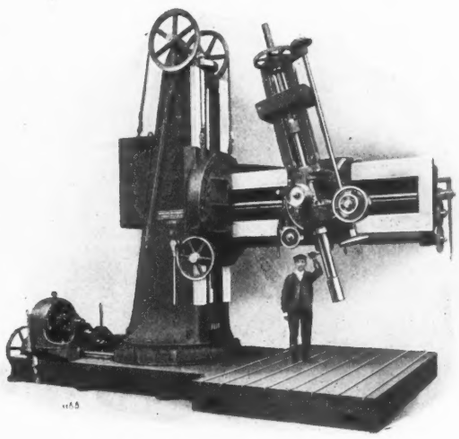
Radial Drilling Machines

FOR HEAVY WORK.

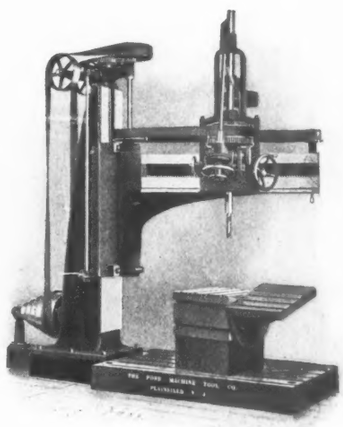
Built in three styles, both plain and universal, in eleven sizes, with arms from 3½ to 10 feet radius.



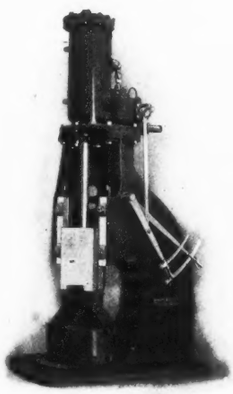
5½-ft. Universal Radial



10-ft. Extra Heavy Universal Radial



6-ft. Heavy Radial



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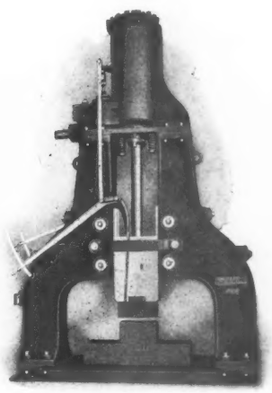
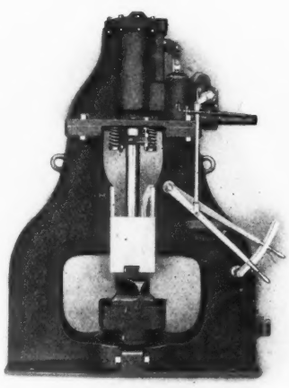
Bement Steam Hammers

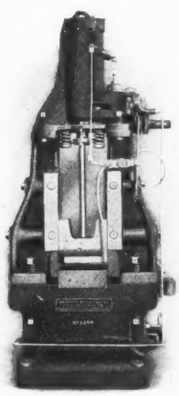
The great variety of types and sizes built fully cover all the requirements of modern forge practice.
Regularly built in sizes from 250 pounds to 15 tons falling weight.
Send for Steam Hammer Catalogue.



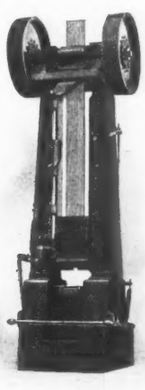
Double Frame



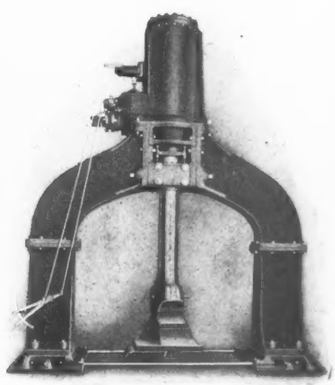
Double Frame Steel Tilting



Steam Drop



Board Drop



Double Open Frame

Niles-Bement-Pond Company,

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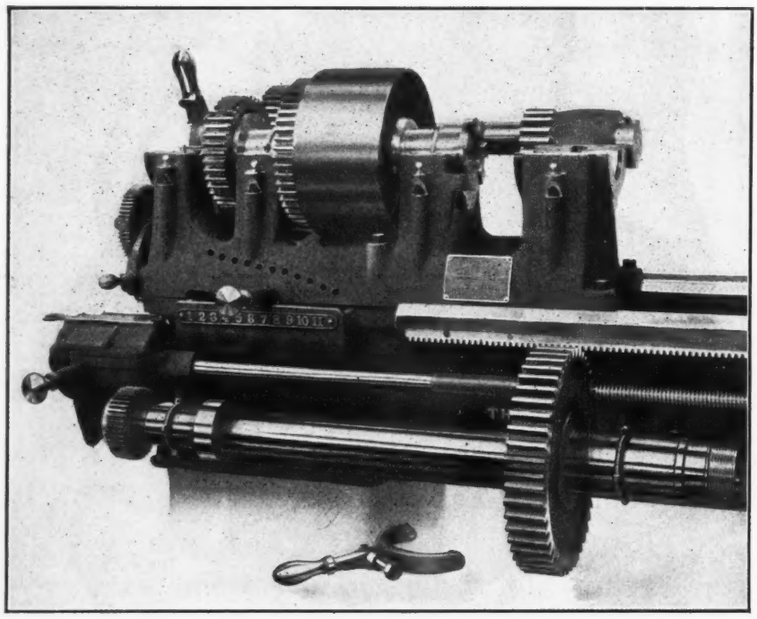
Philadelphia, 21st & Callowhill Sts. Boston, 144 Pearl St. Chicago, Western Union Bldg. St. Louis, 516 No. Third St. London, 23-25 Victoria St., S. W

MORE LATHE WORK

WITH

FEWER LATHES



INCREMENT IN PROFITS is vastly greater, in proportion to the investment, in INCREASING THE OUTPUT of a given plant, than in enlarging it.

Our new High Speed Standard Engine Lathes contain all the advantages of our Quick Change Gear Engine Lathes and in addition HAVE MORE THAN DOUBLE THEIR POWER AND DELIVER THE TOTAL EFFICIENCY of modern High Speed Tool Steels.

SIZES, 14-INCH TO 48-INCH SWING.

The Lodge & Shipley Machine Tool Co.

CINCINNATI, OHIO, U. S. A.

Betts Machine Company

Wilmington, Del., U. S. A.

...Makers of...

Heavy Machine Tools

of the Most Advanced Types

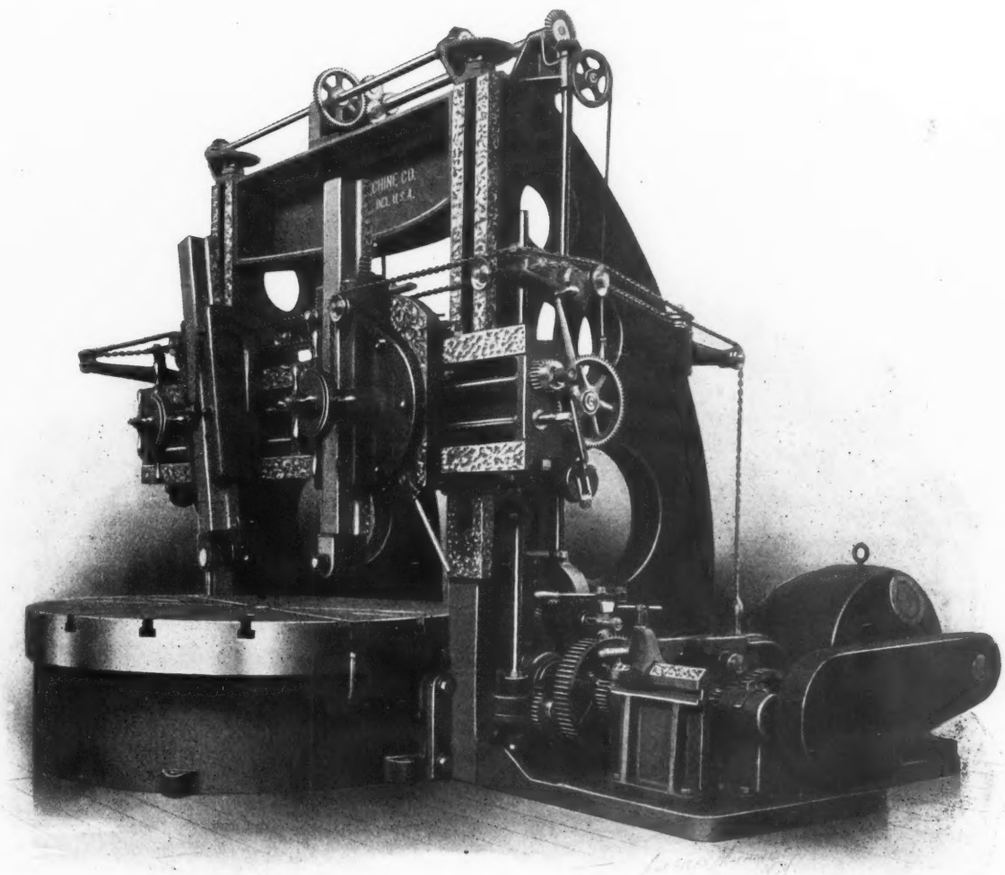
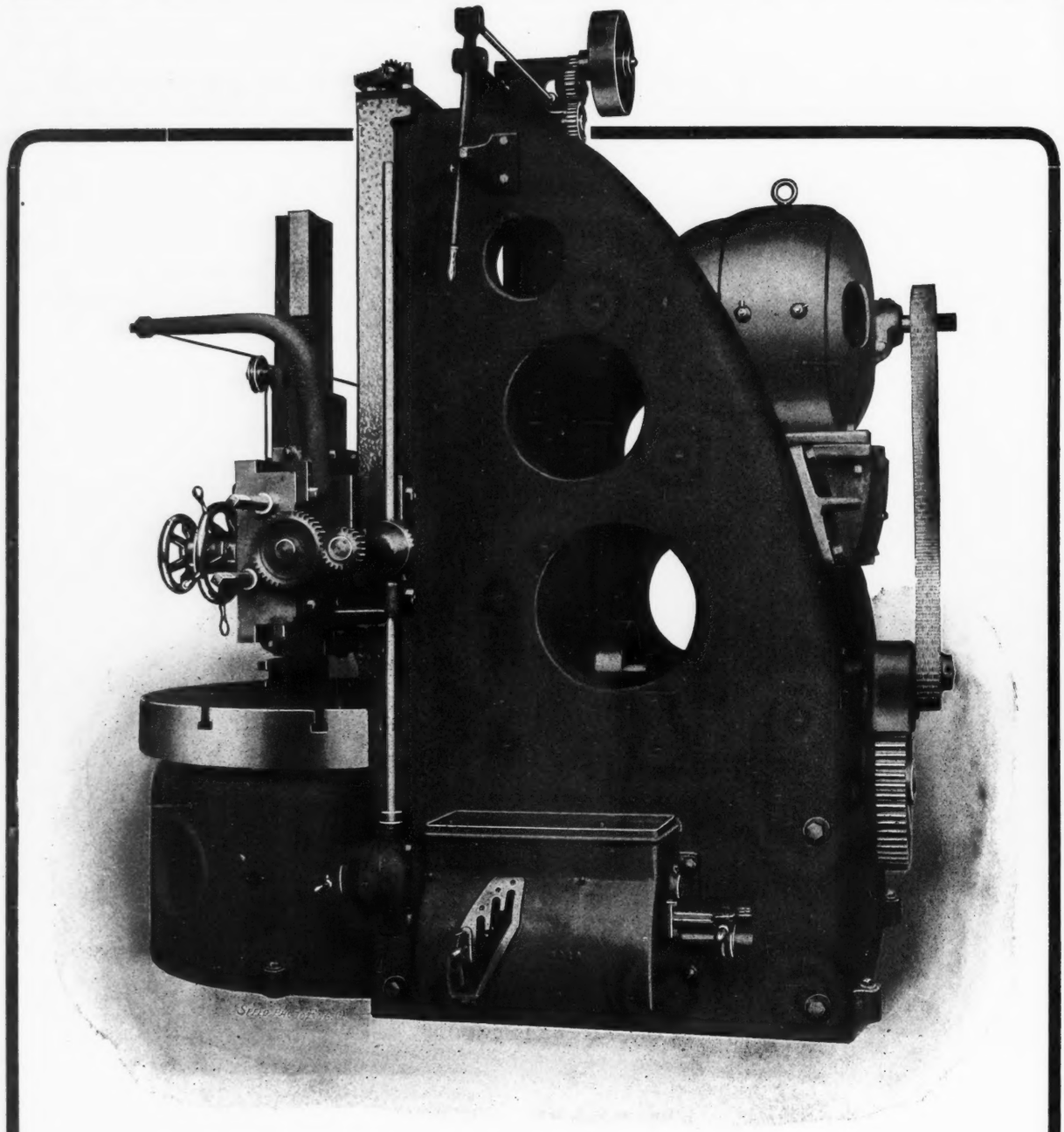


Illustration shows the Patent Worm-Driven, 6-foot Boring and Turning Mill, arranged with Motor and Silent Chain Drive, as exhibited at Louisiana Purchase Exposition, St. Louis, Mo., Block 9, Palace of Machinery.

Vertical Boring Mills -- Slotters -- Planers

Horizontal Boring Machines



Baush Boring and Turning Mills

Have strength and power to handle the heaviest grades of work. They are of most modern type, well proportioned, compact, carefully finished. Sizes include 30″, 37″, 41″, 51″, 54″ and 61″ machines. Motor driven if desired.

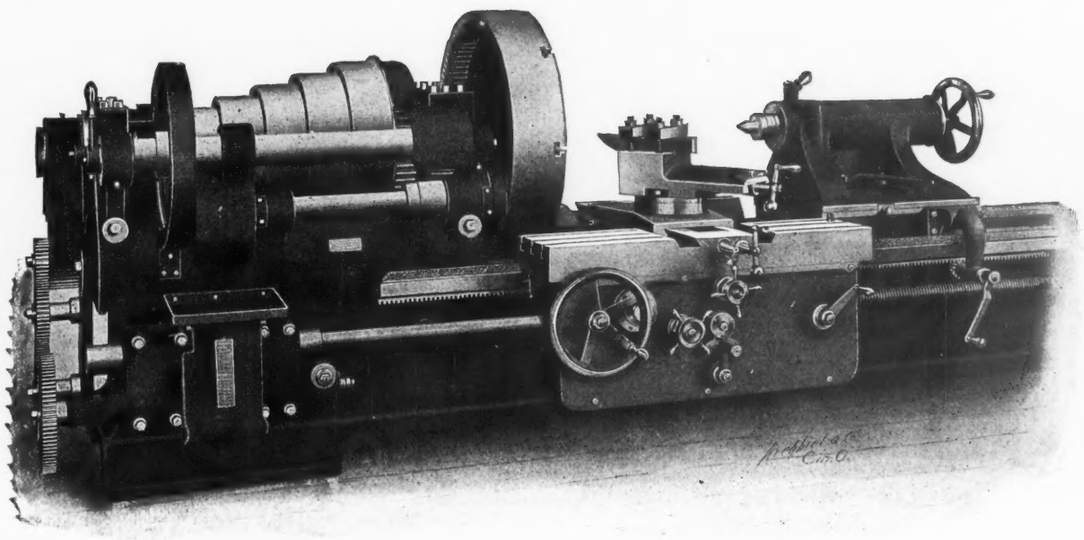
Write us for special features and points of advantage.

Baush Machine Tool Company

Springfield, Mass., U. S. A.

AGENTS—Manning, Maxwell & Moore, New York, Chicago, Cleveland, Philadelphia, Pittsburg, Boston.

BRADFORD'S Heavy 36-in. Triple Geared Lathe



Has the BACK GEARS in front and the pinion delivering power direct to the cutting tool. The tool is fed by a heavy splined screw through a DOUBLE APRON attached to a massive carriage with extra long bearings on the lathe ways.

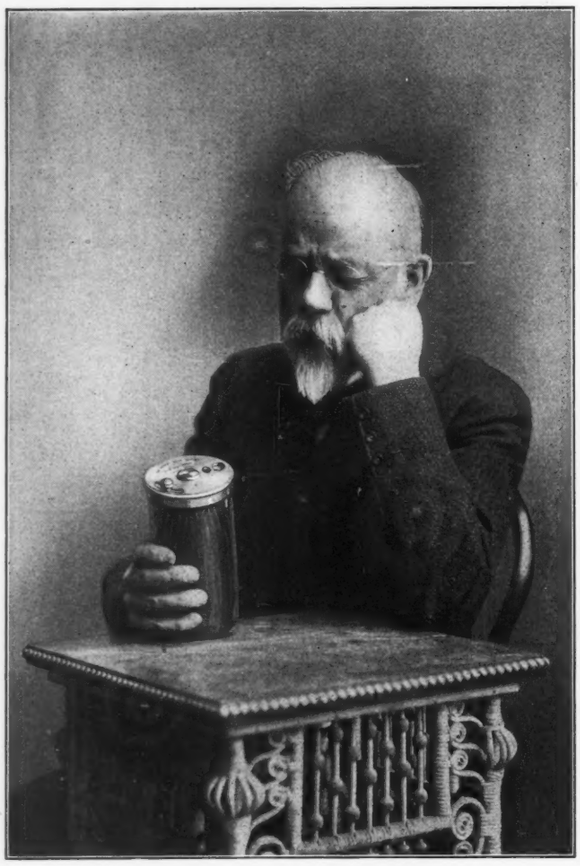
These features give power extraordinary. Every convenience is to be found in this lathe and easily applied by the operator.

More complete details can be had from our Catalogue of Lathes.
Sizes: 14 to 42-inch Swing.

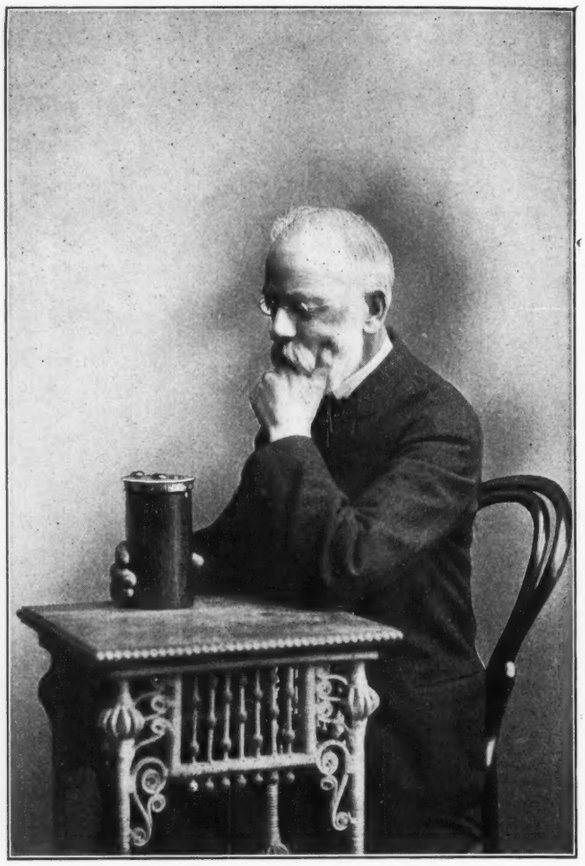
The Bradford Machine Tool Company

Cincinnati, Ohio, U. S. A.

AGENTS—The J. R. Vandyck Co., New York and Philadelphia, Eastern Agents. Pacific Tool & Supply Co., San Francisco, Cal., Agents for Pacific Coast. Foreign Agents—Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Glasgow, Newcastle-on-Tyne. Schuchardt & Schutte, Berlin, Cologne, Vienna, St. Petersburg, Brussels, Stockholm, Paris, Milano, Bilbao.



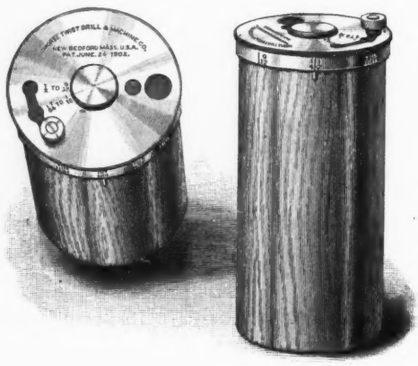
The Professor Contemplates.



He Expresses His Opinion.

"This certainly appears to be a very ingenious and useful article. I see no reason why it should not give perfect satisfaction."

SETS OF DRILLS IN INDEXED CASES.



MORSE TWIST DRILL AND MACHINE CO.

NEW BEDFORD, MASS., U. S. A.

M. H. Ailsworth, PRESIDENT. F. W. Heimick, SEC. AND TREAS. C. A. Pearson, VICE PRESIDENT.

Pearson Boat Construction Company.

Gasoline Launches and Engines.
Small Boats and Canoes.

Duluth, Minn., 5/24/04.

Binsse Machine Co.,
Newark, New Jersey.

Dear Sirs:-

Yours of the 17th inst. to hand. In reply will say that we have a Binsse Horizontal Boring Machine in our shop and it is proving very satisfactory. We are doing the class of work shown by *leaflet "A" and are making even better time than one in 60 minutes. I have had a Binsse Horizontal Boring Machine in my shop for the past three years, and can say that I would not attempt to compete in the gas engine market without one of these machines. I find it valuable not only on gas engine work, but one of the handiest tools a shop could have for general utility. I will also say this machine is built along the most practical lines and that I have found it exceptionally accurate--in fact, while I was with the Racine Boat Mfg. Co. of Racine, Wis., I bored out several hundred cylinders for the Milwaukee Motor Mfg. Co., on which I was allowed a limit less than one thousandth only, and a machine that will turn out work in this quantity with such accuracy as these were turned out, must be of the best workmanship. We are greatly pleased with our Boring Machine.

Yours truly,
PEARSON BOAT CONSTRUCTION CO.,
By J. L. Schwab.
Supt.

*See page 11 May number MACHINERY.

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R. & J. MORISON & BEARBY,
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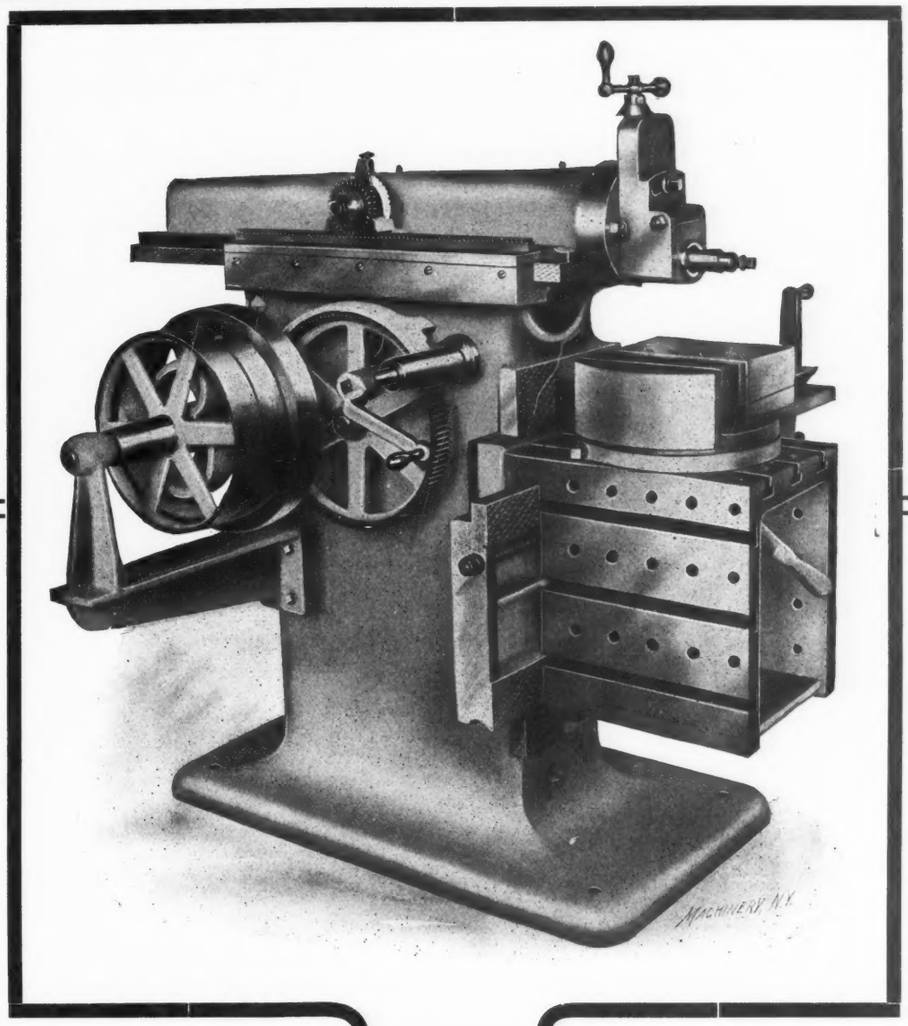

THE HENDEY SHAPER

The Hendey Shaper is Radically Different from other Shapers. In the first place, it is a Friction-Clutch, Gear-Driven Machine, which means that the Driving Power applied to the Ram is Constant, Maintaining the Maximum Application of Power whether on a long or a short stroke and in any position of stroke.

The Patented Friction Clutch is an Elastic Continuous-Rim Wheel, and does its work Quietly, but with a Bulldog Certainty. Strange to say, this Clutch works best when oiled a little every day. What other good points? Note the built-up bearing of Cross-head on Column of Base—raised to top of table. It means so much more added support and counteracts strain of cut at outer end of table. See the heavy box table combining with its saddle in One Solid Casting—more Substantial and Rigid than where table is screwed to face of saddle.

Also you very often want to spline a shaft. Just slide it right through the opening in base under ram. Base thus affords a means of supporting your shaft at outer end.

Those who use Hendey Shapers know them to be Good Ones. *Write us about joining the ranks.*

The Hendey Machine Co., Torrington, Conn., U. S. A.

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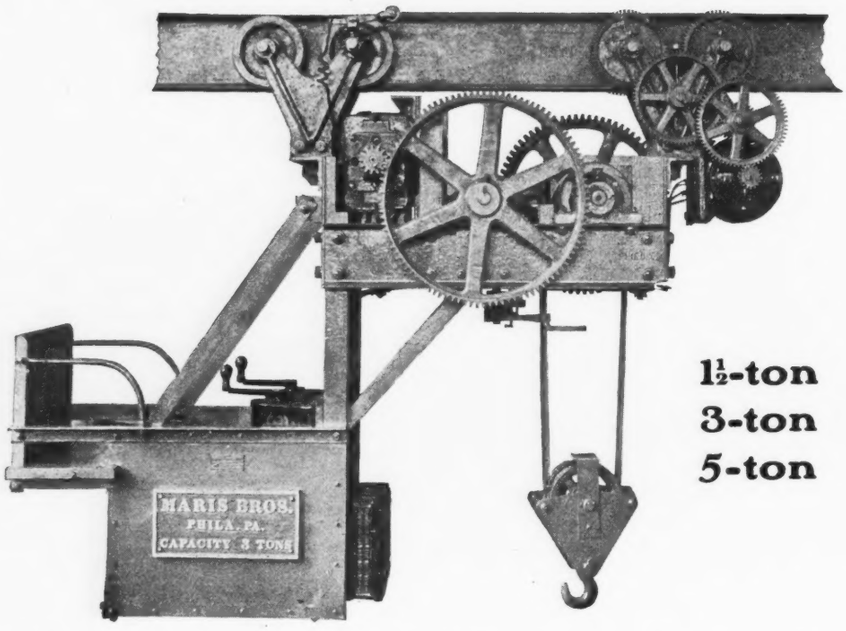
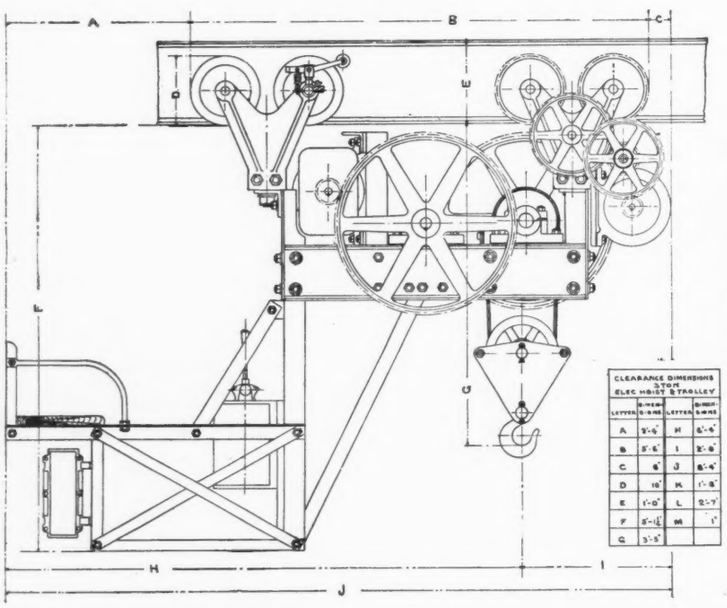
Electric I Beam Travellers



1½-ton
3-ton
5-ton

Built with swivel trucks for curved track or rigid trucks for straight track. Operated from cage or by cords from floor. Hoist and trolley motion by motor or hoist by motor and trolley by hand chain.



CLEARANCE DIMENSIONS 3 TON ELEC HOIST & TROLLEY			
LETTER	15" I BEAM S.W.G.	LETTER	15" I BEAM S.W.G.
A	2'-6"	H	6'-6"
B	5'-6"	I	8'-6"
C	6"	J	8'-6"
D	10"	K	1'-8"
E	1'-0"	L	2'-7"
F	5'-1½"	M	1"
G	3'-5"		

To run on overhead I beam track and used for handling materials from cars to storage, around the shop, to machine tools, in warehouse, etc. Compact, note the clearances. Rapid. Automatic cutout to prevent overrunning the hook in hoisting. All parts readily accessible. Enclosed cab for outdoor use if desired.

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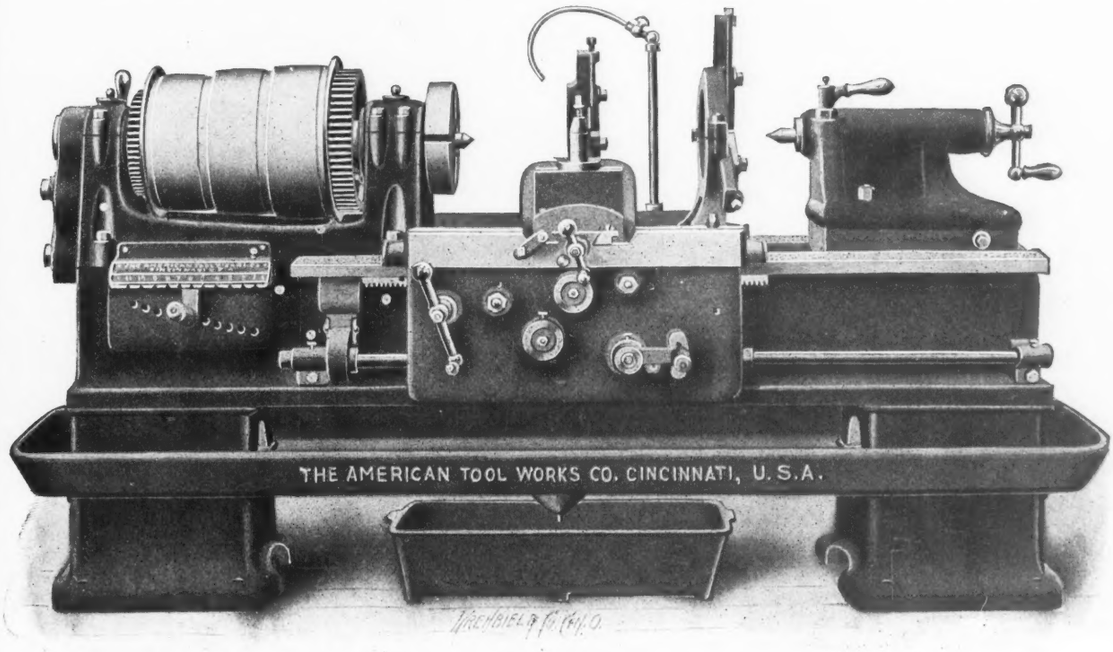

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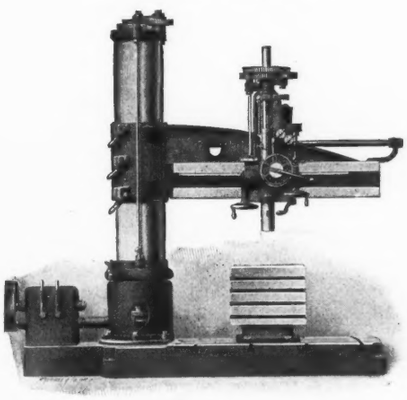
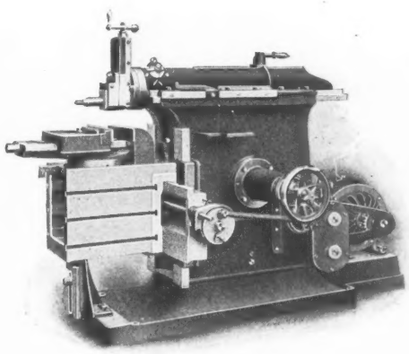
THE GREATEST OF ALL THE "HIGH SPEED" LATHES

WE HAVE PROOFS in the words of our customers. This wonderful machine is working revolutions in shop methods wherever installed. If you are not familiar with this truly remarkable tool, and are interested in the question, let us send full data.



We equip any of our machine tools with improved electric motor drive.



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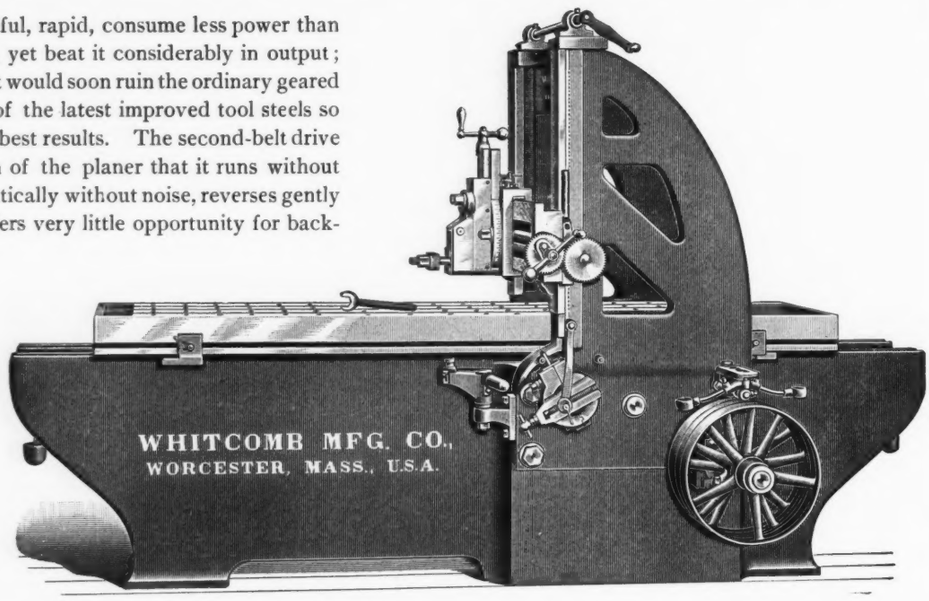
They are powerful, rapid, consume less power than a full geared planer, yet beat it considerably in output; will stand speeds that would soon ruin the ordinary geared tool, and take care of the latest improved tool steels so as to bring out their best results. The second-belt drive so softens the action of the planer that it runs without jar or shock and practically without noise, reverses gently yet promptly and offers very little opportunity for backlash to appear in the gearing. Simple in construction, not liable to get out of order and the most convenient planers on the market.

New Planer Catalogue mailed on request.



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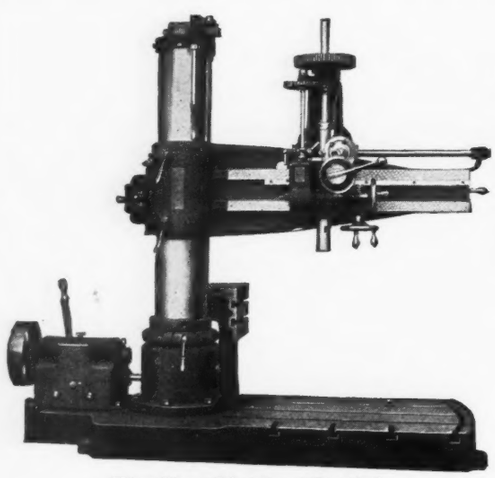

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"After several months use of one of your #1 Bickford Drills, we found the same to be so satisfactory and to effect such a saving in time over any of the other makes of Radial Drills in our works that we have placed our order with you, through your representative Mr. Wm. E. Shipley, for two more tools of the same size and construction as the first one, with which we will replace two Radial Drills of other make.

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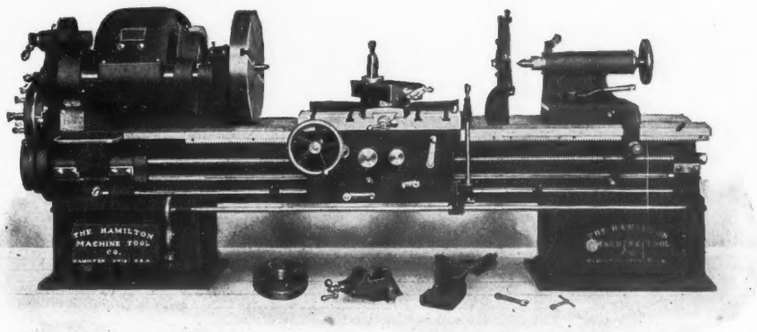
68A—H.P.

Motor-Driven "Hamilton" Lathe.



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Only one of the ways in which the motor can be applied. Other methods described in catalog No. 4, sent on request. We build lathes from 14 to 36-inch swing, Style "A" with Quick Change Mechanism, Style "B" with Standard Change Gearing.

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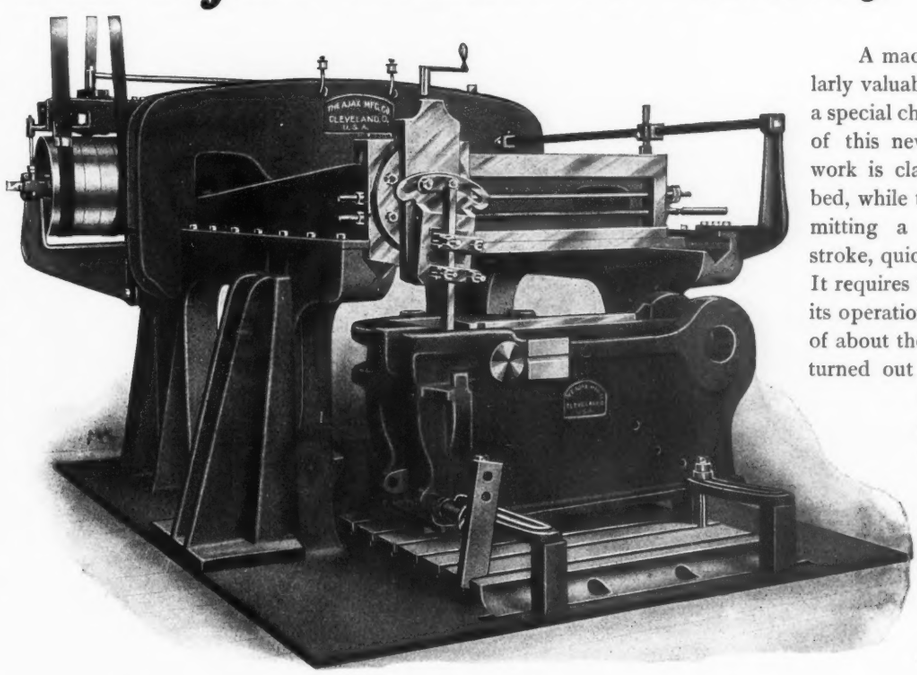

A machine that is particularly valuable on heavy work of a special character. The feature of this new planer is that the work is clamped to a stationary bed, while the head moves, permitting a very rapid cutting stroke, quick reverse and return. It requires very little power for its operation, and where castings of about the same size are to be turned out in quantities is the most economical machine that can be used.

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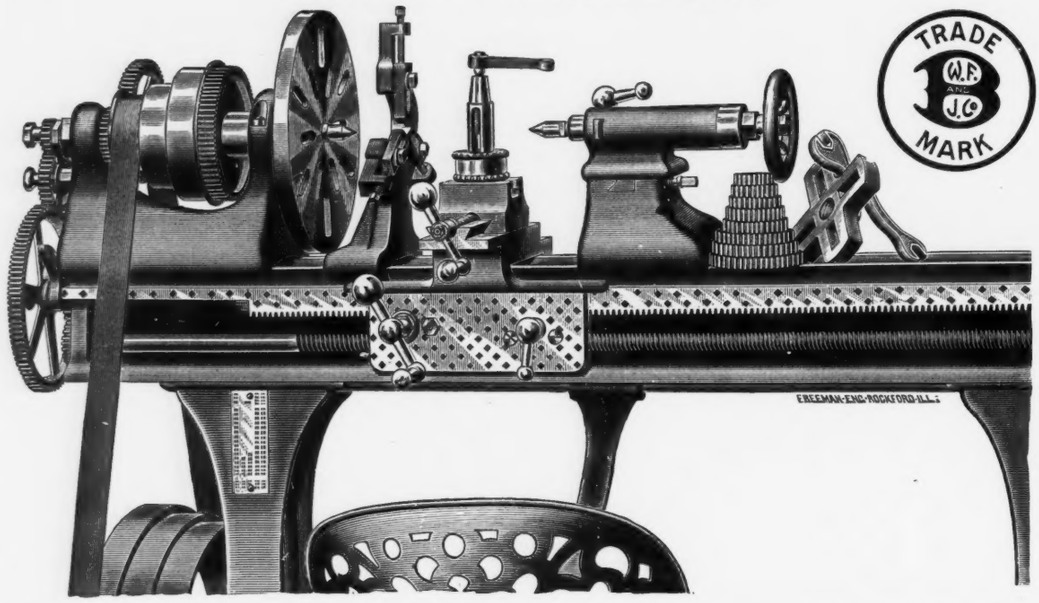

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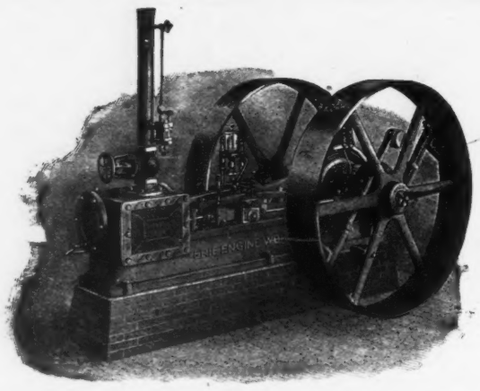

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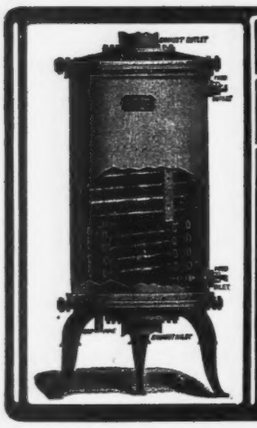

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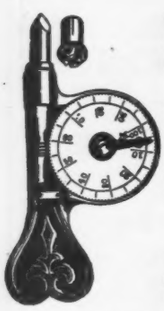

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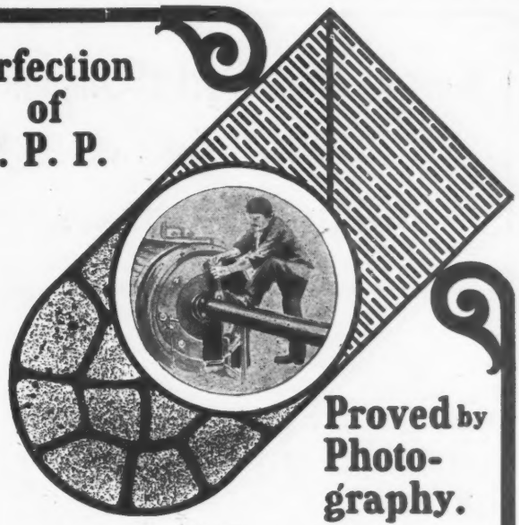

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It sets itself—crowding the rod only during that part of the stroke when steam is trying to get through the stuffing box. This means

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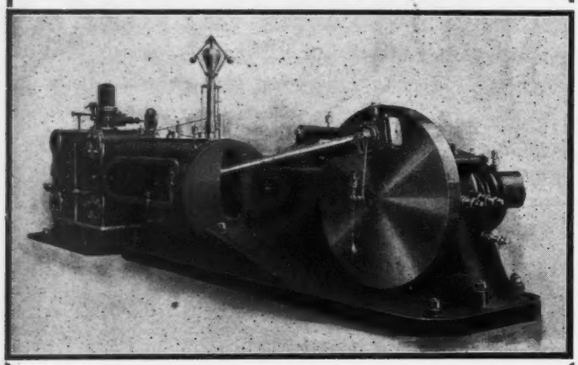

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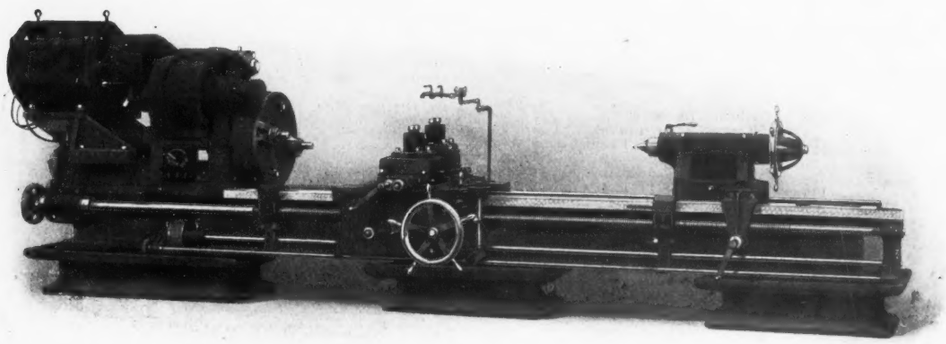

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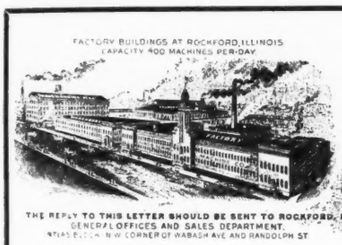
CROCKER-WHEELER COMPANY is now putting on the market alternating current generators, transformers and accessories of the most perfect design and construction, adapted to American practice. Opportunities to bid on this apparatus are invited.


FACTORY BUILDINGS AT ROCKFORD, ILLINOIS
CAPACITY 900 MACHINES PER DAY
THE REPLY TO THIS LETTER SHOULD BE SENT TO ROCKFORD, ILL.
GENERAL OFFICES AND SALES DEPARTMENT.

Illinois Sewing Machine Co.
MANUFACTURERS OF
New Royal
SEWING MACHINES.

ROCKFORD, ILL. June 6th, 1904.

Messrs. Hermann Boker & Co.,
#57-63 N. Desplaines St.,
Chicago, Ill.,

Gentlemen:-

Replying to yours of the 31st. ult. which was received during the writers absence. We have made several tests of the Novo Steel for milling cutters, lathe tools etc., Up to the present writing the steel has given us good satisfaction.

In one instance on a milling cutter used for profiling, the product was at least eight to one over the ordinary steel with the same number of grindings for the cutter.

We regret that we are unable to give you definite figures in regard to this matter at the present time.

Yours truly,
Illinois Sewing Machine Co.,
Per C E Davis
Gen. Supt.

Dict. C.E. Davis,
EES.

Novo is on Top

Novo Milling Cutters

are far ahead of cutters from carbon tool steel.

HermannBoker&Co.

101-103 Duane St., New York.

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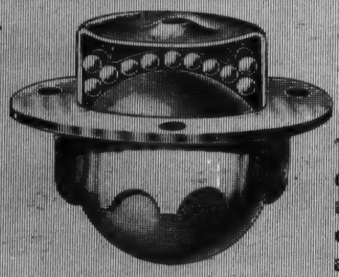
AN ORDER FOR 13,000,000 STEEL BALLS



This is the largest order on record. It was recently placed with us by the Acme Ball Bearing Caster Co., of Chappaqua, N. Y. It is certainly worth while describing the product which requires so many balls. The Acme caster has this pre-eminent advantage over all other casters. Its head is a large ball set in a socket and rolling on forty smaller balls. It carries its load directly over the center of gravity and so the heaviest weights may be moved by the hand of a child

Good idea, isn't it?

By the way, the 13,000,000 balls we have contracted to make for these casters will be first grade, one-eighth inch in diameter. We couldn't tackle such an order if our output wasn't in excess of 1,000,000 a day

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Hollow Hexagon Turret Lathes

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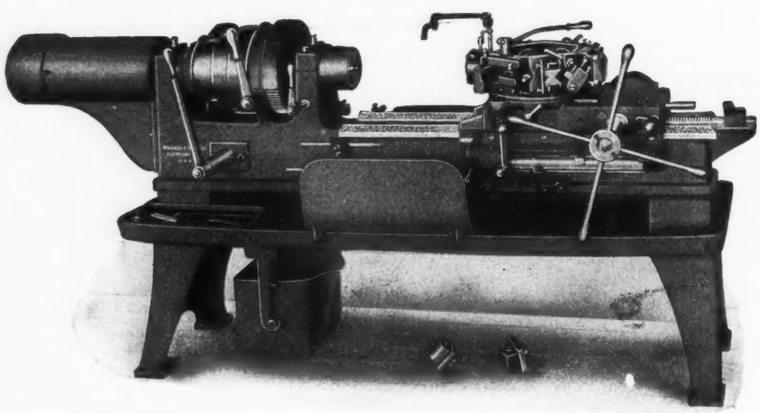

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No. 3
3″ x 36″.

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Cleveland, Ohio, U. S. A.

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Ingersoll-Sergeant Drill Co., New York.
Manning, Maxwell & Moore, New York.
Rand Drill Co., New York.

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Curtis & Co. Mfg. Co., St. Louis, Mo.
Garry Iron & Steel Co., Cleveland, O.
General Pneumatic Tool Co., Montour Falls, N. Y.
Northern Engineering Wks., Detroit, Mich.

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Stow Flexible Shaft Co., Philadelphia, Pa.

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Lucas Mch. Tool Co., Cleveland, O.
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Ball Bearings.
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Blue Print Machines.
Eugene Dietzgen Co., Chicago, Ill.
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Carborundum Co., Niagara Falls, N. Y.

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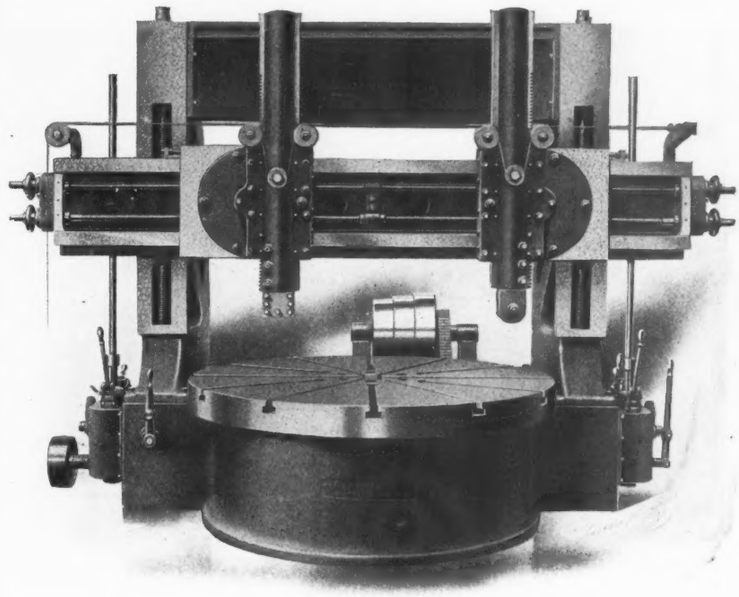

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Powerful Worm Drive. 8 table speeds without stopping. 8 geared feeds for each head. Quick travel for all parts. Motor or Belt Drive. Designed for use of High Speed Steel.

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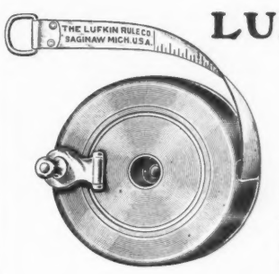

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...AND...

MEASURING TAPES

Guaranteed accurate. Made of best material. For sale everywhere.

ONE of our special tapes is the "Artisan" Steel Tape, made in 8, 12, 15 and 20-foot lengths, graduated feet, inches and 16ths. Neat nickel plated case. Diameter measurements on reverse side, if you like—the handiest tape made; gives the exact diameter of circular bodies by measuring circumference.

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All operations performed at one time is the way the **"Acme Automatic"**—the wholesale screw machine—turns out duplicate parts. The operations on this Standard Set Screw consisting of: **Forming Head—Cupping and Beveling—Removing surplus stock, approximately one half—Removing surplus stock, the balance—Threading—Cutting-off**—are all done on the **Acme** in the time required for removing half the surplus stock.

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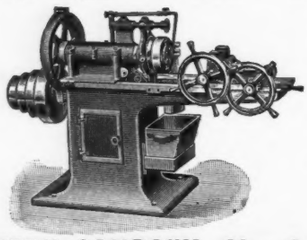
Schuchardt & Schutte, General Foreign Representatives.

We carry complete stock of SET and CAP Screws. Specials made to order.

Bolt Threaders, Headers and Nut Tappers,

Write to us for anything you want in this line.



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ESTABLISHED 1876

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Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.

Chains, Driving.
Link Belt Engineering Co., Philadelphia, Pa.
Morse Chain Co., Trumansburg, N. Y.

Chain Blocks, Differential, Duplex and Triplex.
Yale & Towne Mfg. Co., New York.

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R. H. Brown & Co., New Haven, Conn.
Cushman Chuck Co., Hartford, Conn.
E. Horton & Son Co., Windsor Locks, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
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Westcott Chuck Co., Oneida, N. Y.
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Whitney Mfg. Co., Hartford, Conn.

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Akron Elec. Mfg. Co., Akron, O.
Carlyle Johnson Mch. Co., Hartford, Conn.
Jacobson Mch. Mfg. Co., Warren, Pa.
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John T. Burr & Son, Brooklyn, N. Y.
Diamond Drill & Mch. Co., Birdsboro, Pa.

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Akron Elec. Mfg. Co., Akron, O.

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S. Obermayer Co., Cincinnati, O.

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W. P. Davis Mch. Co., Rochester, N. Y.

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Coburn Trolley Track Mfg. Co., Holyoke, Mass.
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Northern Engineering Wks., Detroit, Mich.
North Penn Iron Co., Philadelphia, Pa.
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Wm. Sellers & Co., Inc., Philadelphia, Pa.
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McCullough-Dalzell Crucible Co., Pittsburg, Pa.
S. Obermayer Co., Cincinnati, O.

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Northern Engineering Wks., Detroit, Mich.
S. Obermayer Co., Cincinnati, O.

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Bignall & Keeler Mfg. Co., Edwardsville, Ill.
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Hurlbut-Rogers Mch. Co., So. Sudbury, Mass.
Merrell Mfg. Co., Toledo, O.
Pond Mch. Tool Co., New York.
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Wm. Sellers & Co., Inc., Philadelphia, Pa.
Standard Engineering Co., Ellwood City, Pa.
Stoever Fdry & Mch. Co., Myerstown, Pa.
Warner & Swasey Co., Cleveland, O.

Diamond Tools.
Dickinson, Thos. L., New York.
Steel Set Diamond Co., New York.

Dies. (See Taps and Dies.)

Die Heads, Self-Opening and Adjustable.
Geometric Drill Co., New Haven, Conn.
Modern Tool Co., Erie, Pa.

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The Winkley Co., Hartford, Conn.

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Kidder, R. E., Worcester, Mass.

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Pratt & Whitney Co., Hartford, Conn.
Wilmarth & Morman Co., Grand Rapids, Mich.

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Kent, Edwin R., & Co., Chicago, Ill.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland, O.
Syracuse Twist Drill Co., Syracuse, N. Y.

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Aurora Tool Works, Aurora, Ind.
Baker Bros., Toledo, O.
B. F. Barnes Co., Rockford, Ill.
W. F. & J. Barnes Co., Rockford, Ill.
H. G. Barr, Worcester, Mass.
Baush Mch. Tool Co., Springfield, Mass.
Betts Mch. Co., Wilmington, Del.
Bickford Drill & Tool Co., Cincinnati, O.
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Burke Mchy. Co., Cleveland, O.
Cincinnati Mch. Tool Co., Cincinnati, O.
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Dreses Mch. Tool Co., Cincinnati, O.
Duff Mch. Co., Lowell, Mass.
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Foote, Burt & Co., Cleveland, O.

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Hamilton Mch. Tool Co., Hamilton, O.
Knecht Bros. Co., Cincinnati, O.
Mueller Mch. Tool Co., Cincinnati, O.
Moline Tool Co., Moline, Ill.
Montgomery & Co., New York.
National Auto. Tool Co., Dayton, O.
New Haven Mfg. Co., New Haven, Conn.
Pond Mch. Tool Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
A. E. Quint, Hartford, Conn.
Francis Reed Co., Worcester, Mass.
Sibley Mch. Tool Co., So. Bend, Ind.
Sloan & Chace Mfg. Co., Newark, N. J.
J. E. Synder & Son, Worcester, Mass.
Vanderbeek Tool Wks., Hartford, Conn.
Washburn Shops, Worcester, Mass.
Wily & Russell Mfg. Co., Greenfield, Mass.
Young, J. W., Chicago, Ill.

Drilling Machines, Portable.
Bartz, Wygant & Brown, Hornellsville, N. Y.
Hisey-Wolf Mch. Co., Cincinnati, O.
Stow Flexible Shaft Co., Philadelphia, Pa.
Wyman & Gordon, Worcester, Mass.

Dynamos.
Akron Electrical Mfg. Co., Akron, O.
Bissell, F., Co., Toledo, O.
Crocker-Wheeler Co., Ampere, N. J.
Emerson Electric Mfg. Co., St. Louis, Mo.
Northern Electrical Mfg. Co., Madison, Wis.
B. F. Sturtevant Co., Boston; Gen'l Office and Works, Hyde Park, Mass.

Elevators.
Howard Iron Works, Buffalo, N. Y.
Morse Elevator Wks., Philadelphia, Pa.

Emery Wheels.
Abrasive Material Co., Philadelphia, Pa.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Hampden Corundum Wheel Co., Brightwood, Mass.
Northampton Emery Wheel Co., Leeds, Mass.
Norton Emery Wheel Co., Worcester, Mass.
Safety Emery Wheel Co., Springfield, O.
Springfield Mfg. Co., Bridgeport, Conn.
Sterling Emery Wheel Mfg. Co., Tiffin, O.
Vitrified Wheel Co., Westfield, Mass.

Emery Wheel Dresser.
Geo. H. Calder, Lancaster, Pa.
Morton Mfg. Co., Muskegon Heights, Mich.
Standard Tool Co., Cleveland, O.
Steel Set Diamond Co., New York.

Engines.
American Blower Co., Detroit, Mich.
Erie Engine Wks., Erie, Pa.
Murray Iron Wks., Burlington, Ia.
New Britain Mch. Co., New Britain, Conn.
B. F. Sturtevant Co., Boston; Gen'l Office and Works, Hyde Park, Mass.

Engines, Gas and Gasoline.
Brown-Cochran Co., Lorain, O.
Charter Gas Engine Co., Sterling, Ill.
Columbus Mch. Co., Columbus, O.
Foos Gas Engine Co., Springfield, O.
Mietz, August, New York.
Otto Gas Engine Wks., Philadelphia, Pa.
Woolley Fdry. & Mch. Works, Anderson, Ind.

Engineering Appliances.
Crane Co., Chicago, Ill.

Exhaust Heads.
Hartford Blower Co., Hartford, Conn.
B. F. Sturtevant Co., Boston; Gen'l Office and Works, Hyde Park, Mass.

Fans, Exhaust, Electric, Ventilating.
American Blower Co., Detroit, Mich.
Hartford Blower Co., Hartford, Conn.
B. F. Sturtevant Co., Boston; Gen'l Office and Works, Hyde Park, Mass.

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Hammacher, Schlemmer & Co., New York.
Hayes File Co., Detroit, Mich.
Mayer & Co., Philadelphia, Pa.
Montgomery & Co., New York.
Nicholson File Co., Providence, R. I.

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Milwaukee Foundry Supply Co., Milwaukee, Wis.

Fillet (Leather).
Butler, A. G., New York.
S. Obermayer Co., Cincinnati, O.

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S. Obermayer Co., Cincinnati, O.

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Coates Clipper Mfg. Co., Worcester, Mass.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Mfg. Co., Binghamton, N. Y.

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Billings & Spencer Co., Hartford, Conn.
Hartford Blower Co., Hartford, Conn.
B. F. Sturtevant Co., Hyde Park, Mass.

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Billings & Spencer Co., Hartford, Conn.
Clapp, E. D., Mfg. Co., Auburn, N. Y.
Keystone Drop Forge Wks., Chester, Pa.
Phosphor Bronze Smelting Co., Philadelphia, Pa.
J. H. Williams & Co., Brooklyn, N. Y.

Foundry Facings, Brushes, Barrows, Shovels, Bellows and Blowers.
S. Obermayer Co., Cincinnati, O.
J. D. Smith Fdry. Sup. Co., Cleveland, O.

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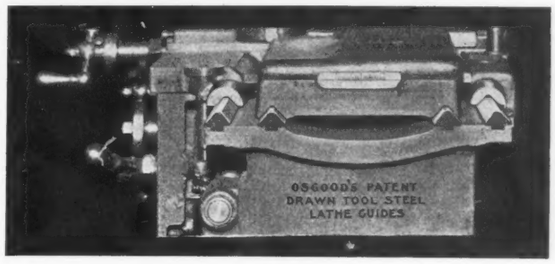
Diamond Drill & Mch. Co., Birdsboro, Pa.
Milwaukee Foundry Supply Co., Milwaukee, Wis.
S. Obermayer Co., Cincinnati, O.
J. D. Smith Fdry. Sup. Co., Cleveland, O.

Friction Cone Pulleys.
G. F. Evans, Newton Center, Mass.

For Alphabetical Index, see Page 24.

Improved Lathes With Tool Steel Guides.



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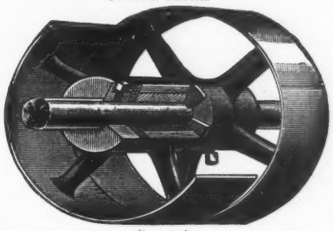
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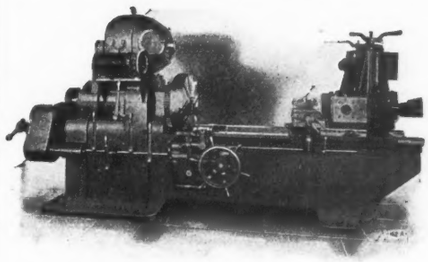

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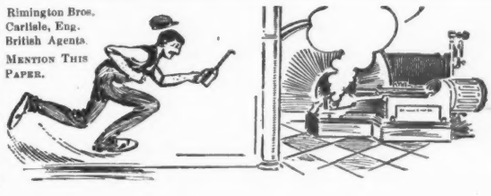

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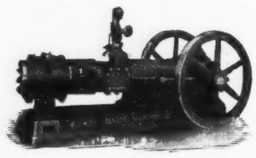

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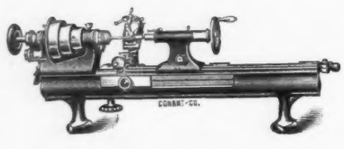

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Pratt & Whitney Co., Hartford, Conn.
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J. T. Slocomb Co., Providence, R. I.
E. G. Smith, Columbia, Pa.
L. S. Starrett Co., Athol, Mass.
J. Wyke & Co., Boston, Mass.

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Arthur Co., New York.
Hugo Bilgram, Philadelphia, Pa.
Boston Gear Wks., Boston, Mass.
H. W. Caldwell & Son Co., Chicago, Ill.
Cleveland Gear Wks., Cleveland, O.
Fawcus Mch. Co., Pittsburg, Pa.
Foster-Kimball Mch. Co., Chicago, Ill.
Wm. Ganschow, Chicago, Ill.
Garry Iron & Steel Co., Cleveland, O.
Gleason Works, Rochester, N. Y.
Grant Gear Wks., Boston, Mass.
Horsburg & Scott Co., Cleveland, O.
New Process Raw Hide Co., Syracuse, N. Y.
R. D. Nuttall Co., Pittsburg, Pa.
Philadelphia Gear Wks., Philadelphia, Pa.

Gearing.
Earle Gear and Mch. Co., Philadelphia, Pa.
Fawcus Mch. Co., Pittsburg, Pa.
Morse Elevator Wks., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.

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Becker-Brainard Milling Mch. Co., Hyde Park, Mass.
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Fawcus Mch. Co., Pittsburg, Pa.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Pratt & Whitney Co., Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
D. E. Whiton Mch. Co., New London, Conn.

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Gleason Works, Rochester, N. Y.

Gear Shapers.
Fellows Gear Shaper Co., Springfield, Vt.

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S. Obermayer Co., Cincinnati, O.

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W. F. & John Barnes Co., Rockford, Ill.
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Carver Cotton Gin Co., East Bridgewater, Mass.
Diamond Mch. Co., Providence, R. I.
Gisholt Mch. Co., Madison, Wis.
Gould & Eberhardt, Newark, N. J.
Hisey-Wolf Mch. Co., Cincinnati, O.
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Modern Tool Co., Erie, Pa.
Montgomery & Co., New York.
Norton Emery Wheel Co., Worcester, Mass.
Norton Grinding Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Safety Emery Wheel Co., Springfield, O.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Springfield Mfg. Co., Bridgeport, Conn.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Mfg. Co., Binghamton, N. Y.
Whitney Mfg. Co., Hartford, Conn.

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Beaudry & Co., Boston, Mass.
Bement, Miles & Co., Philadelphia, Pa.
Billings & Spencer Co., Hartford, Conn.
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Bradley, C. C., & Son, Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Dienelt & Eisenhardt, Philadelphia, Pa.
R. E. Kidder, Worcester, Mass.
Merrill Bros., Brooklyn, N. Y.
Pratt & Whitney, Hartford, Conn.
Scranton & Co., New Haven, Conn.
Toledo Mch. & Tool Co., Toledo, O.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury, Conn.

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Chicago Flexible Shaft Co., Chicago, Ill.
Coes Wrench Co., Worcester, Mass.

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Acme Machinery Co., Cleveland, O.
National Mchy. Co., Tiffin, O.

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Hartford Blower Co., Hartford, Conn.
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Hartford Blower Co., Hartford, Conn.
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Stewart Heater Co., Buffalo, N. Y.

Hoists.
Garry Iron & Steel Co., Cleveland, O.
Volney W. Mason & Co., Providence, R. I.
J. D. Smith Fdry. Sup. Co., Cleveland, O.

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Classified Index to Advts. (Continued).

Hoists, Pneumatic.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Garry Iron & Steel Co., Cleveland, O.
General Pneumatic Tool Co., Montour Falls, N. Y.
Rand Drill Co., New York.
Stow Flexible Shaft Co., Philadelphia, Pa.

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Northern Engineering Wks., Detroit, Mich.

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Garry Iron & Steel Co., Cleveland, O.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury, Conn.
Watson-Stillman Co., New York.

Hydraulic Tools.
Diamond Drill & Mch. Co., Birdsboro, Pa.
Watson-Stillman Co., New York.

Indicators.
L. S. Starrett Co., Athol, Mass.
R. Woodman Mfg. & Supply Co., Boston, Mass.

Injectors.
Jenkins Bros., New York.
Ohio Injector Co., Wadsworth, O.

Jacks.
Dienelt & Eisenhardt, Philadelphia, Pa.
Garry Iron & Steel Co., Cleveland, O.
A. O. Norton, Boston, Mass.
Watson-Stillman Co., New York.

Key-Seaters.
Baker Bros., Toledo, O.
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W. P. Davis Mch. Co., Rochester, N. Y.
Mitts & Merrill, Saginaw, Mich.
Morton Mfg. Co., Muskegon Heights, Mich.

Lathes.
American Tool Works Co., Cincinnati, O.
Am. Turret Lathe Mfg. Co., Warren, Pa.
Baird Mchy. Co., Pittsburg, Pa.
Wm. Barker & Co., Cincinnati, O.
B. F. Barnes Co., Rockford, Ill.
W. F. & J. Barnes Co., Rockford, Ill.
P. Blaisdell & Co., Worcester, Mass.
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Brown & Sharpe Mfg. Co., Providence, R. I.
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W. P. Davis Mch. Co., Rochester, N. Y.
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Faneuil Watch Tool Co., Brighton, Mass.
Fay & Scott, Dexter, Me.
Fenn-Sadler Mch. Co., Hartford, Conn.
Flather & Co., Nashua, N. H.
Gisholt Mch. Co., Madison, Wis.
Goddard Mch. Co., Holyoke, Mass.
Gould & Eberhardt, Newark, N. J.
Greaves, Klusman & Co., Cincinnati, O.
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Hendey Mch. Co., Torrington, Conn.
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Lodge & Shipley Mch. Tool Co., Cincinnati, O.
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Shepard Lathe Co., Cincinnati, O.
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Springfield Mch. Tool Co., Springfield, O.
Stark Tool Co., Waltham, Mass.
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Warner & Swasey Co., Cleveland, O.
W. C. Young Mfg. Co., Worcester, Mass.

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Lathe and Planer Tools.
Armstrong Bros. Tool Co., Chicago, Ill.
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Pratt & Whitney Co., Hartford, Conn.
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Lufkin Rule Co., Saginaw, Mich.
Massachusetts Tool Co., Greenfield, Mass.
Montgomery & Co., New York.
Pratt & Whitney Co., Hartford, Conn.

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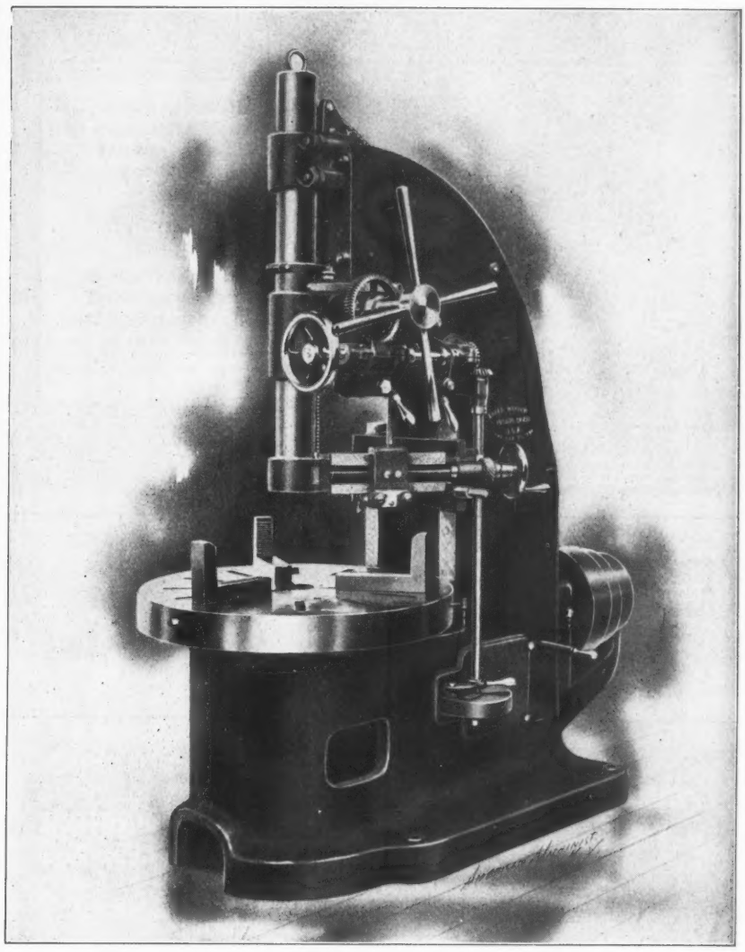

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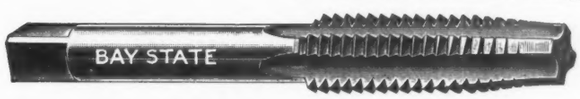

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Stark Tool Co., Waltham, Mass.
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Syracuse Twist Drill Co., Syracuse, N. Y.
J. H. Williams & Co., Brooklyn, N. Y.
J. Wyke & Co., Boston, Mass.

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C. H. Besly & Co., Chicago, Ill.
Montgomery & Co., New York.
Pratt & Whitney Co., Hartford, Conn.

Mandrels.
Cleveland Twist Drill Co., Cleveland, O.
W. H. Nicholson & Co., Wilkesbarre, Pa.
Rich, Geo. R., Mfg. Co., Chicago, Ill.
Western Tool and Mfg. Co., Springfield, O.

Manheads (pressed steel).
Glasgow Iron Co., Pottstown, Pa.

Marking Crayons.
D. M. Steward Mfg. Co., Chattanooga, Tenn.

Mechanical Draft.
American Blower Co., Detroit, Mich.
Hartford Blower Co., Hartford, Conn.
B. F. Sturtevant Co., Boston; Gen'l Office and Works, Hyde Park, Mass.

Metal.
Phosphor Bronze Smelting Co., Philadelphia, Pa.

Metal Polish.
Hoffman, George W., Indianapolis, Ind.

Milling Machines.
Adams Co., Dubuque, Ia.
Aurora Tool Works, Aurora, Ind.
Beaman & Smith Co., Providence, R. I.
Becker-Brainard Milling Mch. Co., Hyde Park, Mass.
Bement, Miles & Co., Philadelphia, Pa.
Carter & Hakes Mch. Co., Winsted, Conn.
Cincinnati Milling Mch. Co., Cincinnati, O.
Cleveland Auto. Mch. Co., Cleveland, O.
R. M. Clough, Tolland, Conn.
Dwight Slate Mch. Co., Hartford, Conn.
Fox Mch. Co., Grand Rapids, Mich.
Hendey Mch. Co., Torrington, Conn.
Ingersoll Milling Mch. Co., Rockford, Ill.
Kempsmith Mfg. Co., Milwaukee, Wis.
R. K. Le Blond Mch. Tool Co., Cincinnati, O.
Newton Mch. Tool Wks., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Waltham Watch Tool Co., Springfield, Mass.
Whitney Mfg. Co., Hartford, Conn.

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Becker-Brainard Milling Mch. Co., Hyde Park, Mass.
Boker, Hermann, & Co., New York and Chicago.
Boston Gear Works, Boston, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Kent, Edwin R., & Co., Chicago, Ill.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Reliance Mch. & Tool Co., Cleveland, O.
Standard Tool Co., Cleveland, O.
L. S. Starrett Co., Athol, Mass.

Milling Tools (Hollow Adjustable).
Geometric Drill Co., New Haven, Conn.

Molding Machines.
S. Obermayer Co., Cincinnati, O.

Motors.
Giant Motor Co., Elizabeth, N. J.
Steffey Mfg. Co., Philadelphia, Pa.

Motors (Electric).
Akron Electrical Mfg. Co., Akron, O.
Bissell, F., Co., Toledo, O.
Crocker-Wheeler Co., Ampere, N. J.
Emerson Electric Mfg. Co., St. Louis, Mo.
Guarantee Electric Co., Chicago, Ill.
Northern Electrical Mfg. Co., Madison, Wis.
B. F. Sturtevant Co., Boston; Gen'l Office and Works, Hyde Park, Mass.

Name Plates.
Turner Brass Works, Chicago, Ill.

Nozzles.
McCullough-Dalzell Crucible Co., Pittsburg, Pa.

Nut Tappers.
Acme Mchy. Co., Cleveland, O.
National Mchy. Co., Tiffin, O.
Norwalk Mfg. Co., Norwalk, O.
Pratt & Whitney Co., Hartford, Conn.

Oil Cups.
Bay State Stamping Co., Worcester, Mass.
C. H. Besly & Co., Chicago, Ill.
W. M. & C. F. Tucker, Hartford, Conn.
Winkley Co., Hartford, Conn.

Oil-Hole Covers.
Bay State Stamping Co., Worcester, Mass.
W. M. & C. F. Tucker, Hartford, Conn.
Winkley Co., Hartford, Conn.

Oiling Devices.
Nugent, Wm. W., & Co., Chicago, Ill.

Oilless Bearings.
Arguto Oilless Bearing Co., Philadelphia, Pa.

Packing.
Jenkins Bros., New York.
New York Belting & Packing Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.

Patterns, Wood and Metal.
Chicago Pattern Works, Chicago, Ill.

Pattern Letters.
Butler, A. G., New York.

Patents.
J. W. Bevans, Washington, D. C.
Burnham, Royal E., Washington, D. C.
Davidson, Edward C., New York.
Howson & Howson, Philadelphia, Pa.
Spear, Middleton, Donaldson & Spear, Washington, D. C.
Whittlesey, Geo. P., Washington, D. C.

For Alphabetical Index, see Page 24.

Classified Index to Advts. (Continued).

Pattern Shop Equipment.
Colburn Mch. Tool Co., Franklin, Pa.
Fox Machine Co., Grand Rapids, Mich.
R. E. Kidder, Worcester, Mass.

Phosphorizers.
McCullough-Dalzell Crucible Co., Pittsburg, Pa.

Pipe-Cutting and Threading Tools.
Armstrong Mfg. Co., Bridgeport, Conn.
Bignall & Keeler Co., Edwardsville, Ill.
Columbus Mch. Co., Columbus, O.
Curtis & Curtis Co., Bridgeport, Conn.
Eaton, Cole & Burnham Co., New York.
Hart Mfg. Co., Cleveland, O.
Merrell Mfg. Co., Toledo, O.
Oster Mfg. Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.
D. Saunders' Sons, Yonkers, N. Y.
Standard Engineering Co., Ellwood City, Pa.
Stoever Fdry. & Mch. Co., Myerstown, Pa.
Trimont Mfg. Co., Roxbury, Mass.
Williams Tool Co., Erie, Pa.

Planers.
Ajax Mfg. Co., Cleveland, O.
Betts Mch. Co., Wilmington, Del.
P. Blaisdell & Co., Worcester, Mass.
Cincinnati Planer Co., Cincinnati, O.
Detrick & Harvey Mch. Co., Baltimore, Md.
Mark Flather Planer Co., Nashua, N. H.
Gleason Works, Rochester, N. Y.
G. A. Gray Co., Cincinnati, O.
Morton Mfg. Co., Muskegon Heights, Mich.
New Haven Mfg. Co., New Haven, Conn.
Pond Mch. Tool Co., New York.
Pratt & Whitney Co., Hartford, Conn.
W. A. Wilson Mch. Co., Rochester, N. Y.
Whitcomb Mfg. Co., Worcester, Mass.
Woodward & Powell Planer Co., Worcester, Mass.

Plumbago.
S. Obermayer Co., Cincinnati, O.

Pneumatic Tools.
Cleveland Pneumatic Tool Co., Cleveland, O.
General Pneu. Tool Co., Montour Falls, N. Y.
Manning, Maxwell & Moore, New York.
Philadelphia Pneu. Tool Co., Philadelphia, Pa.
Rand Drill Co., New York.

Presses.
Billings & Spencer Co., Hartford, Conn.
E. W. Bliss Co., Brooklyn, N. Y.
Falkenau-Sinclair Mch. Co., Philadelphia, Pa.
Hamilton Mch. Tool Co., Hamilton, O.
Hoefer Mfg. Co., Freeport, Ill.
Lucas Mch. Tool Co., Cleveland, O.
Miner & Peck Mfg. Co., New Haven, Conn.
Springfield Mch. Tool Co., Springfield, O.
Toledo Mch. & Tool Co., Toledo, O.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury, Conn.
Watson-Stillman Co., New York.

Pulley Blocks.
Yale & Towne Mfg. Co., New York.

Pulleys.
Federal Mfg. Co., Cleveland, O.
Howard Iron Works, Buffalo, N. Y.
Poole Eng'r'g & Mch. Co., Baltimore, Md.
Saginaw Mfg. Co., Saginaw, Mich.

Pumps.
Watson-Stillman Co., New York.

Punches and Dies.
Pratt & Whitney Co., Hartford, Conn.
I. P. Richards, Providence, R. I.
Watson-Stillman Co., New York.
W. C. Young Mfg. Co., Worcester, Mass.

Punching and Shearing Machinery.
E. W. Bliss Co., Brooklyn, N. Y.
Cincinnati Punch & Shear Co., Cincinnati, O.
Cleveland Punch & Shear Wks. Co., Cleveland, O.
R. E. Kidder, Worcester, Mass.
Long & Allstatter Co., Hamilton, O.
New Doty Mfg. Co., Janesville, Wis.
Pedrick & Ayer Co., New York.
Pond Mch. Tool Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Royersford Foundry & Mch. Co., Royersford, Pa.
Sutton, C. E., Co., Toledo, O.
Toledo Mch. & Tool Co., Toledo, O.
Watson-Stillman Co., New York.
W. C. Young Mfg. Co., Worcester, Mass.

Rapping Plates.
Milwaukee Fdy. Supply Co., Milwaukee, Wis.

Reamers.
Cleveland Twist Drill Co., Cleveland, O.
F. B. McCrosky Mfg. Co., Meadville, Pa.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
John M. Rogers Boat, Gauge & Drill Works, Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Three Rivers Tool Co., Three Rivers, Mich.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Reamers, Pneumatic.
Philadelphia Pneu. Tool Co., Philadelphia, Pa.
Stow Flexible Shaft Co., Philadelphia, Pa.

Riveters.
Chambersburg Engineering Co., Chambersburg, Pa.
Ingersoll-Sergeant Drill Co., New York.
Manning, Maxwell & Moore, New York.
Philadelphia Pneu. Tool Co., Philadelphia, Pa.
Rand Drill Co., New York.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Roller Bearings.
Auburn Ball Bearing Co., Rochester, N. Y.
Ball Bearing Co., Philadelphia, Pa.
Bantam Mfg. Co., Bantam, Conn.
Hutchison, John, Mfg. Co., Jackson, Mich.
Standard Roller Bearing Co., Philadelphia, Pa.

Saw Blades.
Diamond Saw & Stamping Wks., Buffalo, N. Y.
Goodell-Pratt Co., Greenfield, Mass.
Millers Falls Co., New York.
Montgomery & Co., New York.
West Haven Mfg. Co., New Haven, Conn.

For Alphabetical Index, see Page 24.

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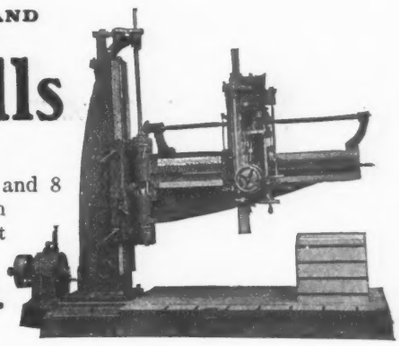

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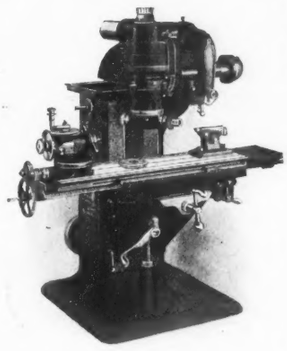

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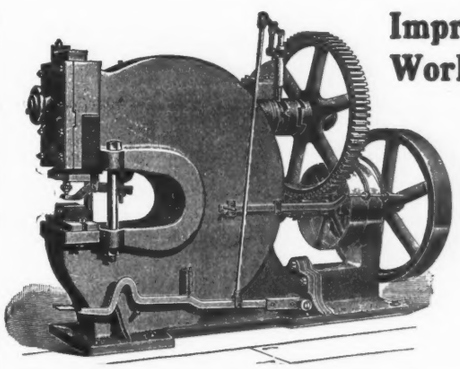

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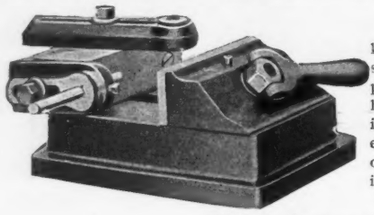

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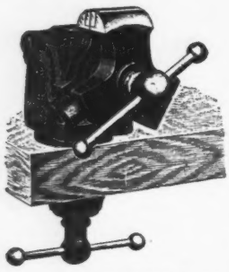

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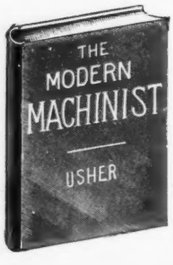

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Diamond Saw & Stamping Wks., Buffalo, N. Y.
Espen-Lucas Mch. Wks., Philadelphia, Pa.
Goodell-Pratt Co., Greenfield, Mass.
Millers Falls Co., New York.
H. T. Story, Chicago, Ill.
West Haven Mfg. Co., New Haven, Conn.

Saws, Band.
Fox Mch. Co., Grand Rapids, Mich.

Schools.
Michigan College of Mines, Houghton, Mich.
Pratt Institute, Brooklyn, N. Y.
The International Corr. School, Scranton, Pa.

Screw Machines.
Asa S. Cook Co., Hartford, Conn.
Jas. D. Mattison, New York.
National-Acme Mfg. Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.
Warner & Swasey Co., Cleveland, O.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Separators, Oil.
National Separator & Mch. Co., Concord, N. H.

Shaft Coupler.
Davis, W. P., Mch. Co., Rochester, N. Y.

Shapers.
Wm. Barker & Co., Cincinnati, O.
Cincinnati Shaper Co., Cincinnati, O.
Flather & Co., Nashua, N. H.
Mark Flather Planer Co., Nashua, N. H.
Fox Mch. Co., Grand Rapids, Mich.
Gould & Eberhardt, Newark, N. J.
Hendey Mch. Co., Torrington, Conn.
Kelly, R. A., Co., Xenia, O.
Morton Mfg. Co., Muskegon Heights, Mich.
New Haven Mfg. Co., New Haven, Conn.
Potter & Johnston Mch. Co., Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Conn.
Queen City Mch. Tool Co., Cincinnati, O.
Smith & Mills, Cincinnati, O.
Springfield Mch. Tool Co., Springfield, O.
John Steptoe Shaper Co., Cincinnati, O.
Stockbridge Mch. Co., Worcester, Mass.
George D. Walcott & Son, Jackson, Mich.

Shop Pans.
Geauga Mfg. Co., Painesville, O.
Kilbourne & Jacobs Mfg. Co., Columbus, O.

Slotting Machines.
Betts Mch. Co., Wilmington, Del.
Clough, R. M., Tolland, Conn.
New Haven Mfg. Co., New Haven, Conn.

Special Machinery.
Beaman & Smith Co., Providence, R. I.
Blanchard Mch. Co., Boston, Mass.
Burke Mchy. Co., Cleveland, O.
Detrick & Harvey Mch. Co., Baltimore, Md.
Fawcus Mch. Co., Pittsburg, Pa.
Fenn-Sadler Mch. Co., Hartford, Conn.
Garry Iron & Steel Co., Cleveland, O.
Hoefer Mfg. Co., Freeport, Ill.
Hollingsworth, Samuel, Plainfield, N. J.
National Mchy. Co., Tiffin, O.
Poole Eng'rg & Mch. Co., Baltimore, Md.
Trump Bros. Co., Wilmington, Del.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury, Conn.
W. A. Wilson Mch. Co., Rochester, N. Y.

Speed Changing Device.
Evans, G. F., Newton Centre, Mass.
Reeves Pulley Co., Columbus, Ind.
Speed Changing Pulley Co., Indianapolis, Ind.

Stamps, Letters and Figures.
Schwerdtle Stamp Co., Bridgeport, Conn.

Steel.
Boker, Hermann, & Co., New York and Chicago.
Federal Mfg. Co., Cleveland, O.
Wm. Jessop & Sons, Ltd., New York.
Kent, Edwin R., & Co., Chicago, Ill.
Standard Pressed Steel Co., Philadelphia, Pa.

Steel Castings and Forgings.
Cooper-Wigand-Cooke Co., New York.
Diamond Drill & Mch. Co., Birdsboro, Pa.
Hay-Budden Mfg. Co., Brooklyn, N. Y.
Wm. Jessop & Sons, Ltd., New York.

Steel Rules.
Brown & Sharpe Mfg. Co., Providence, R. I.
Keuffel & Esser Co., New York.
Lufkin Rule Co., Saginaw, Mich.
Massachusetts Tool Co., Greenfield, Mass.

Stoppers.
McCullough-Dalzell Crucible Co., Pittsburg, Pa.

Taps and Dies.
Bay State Tap & Die Co., Greenfield, Mass.
C. H. Besly & Co., Chicago, Ill.
Butterfield & Co., Derby Line, Vt.
S. W. Card Mfg. Co., Mansfield, Mass.
J. M. Carpenter Tap & Die Co., Pawtucket, R. I.
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Eaton, Cole & Burnham Co., New York.
Geometric Drill Co., New Haven, Conn.
Wm. Jessop & Sons, Ltd., New York.
Modern Tool Co., Erie, Pa.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Reece, E. F., Co., Greenfield, Mass.
Reed Mfg. Co., Erie, Pa.
Reliance Mch. & Tool Co., Cleveland, O.
Superior Tap Co., Springfield, Vt.
Toledo Mch. & Tool Co., Toledo, O.
Wells Bros. Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Tapping Attachments.
Beaman & Smith Co., Providence, R. I.
Cincinnati Mch. Tool Co., Cincinnati, O.
Fosdick Mch. Tool Co., Cincinnati, O.
Modern Tool Co., Erie, Pa.

Tapping Machines.
Baker Bros., Toledo, O.
Burke Mchy. Co., Cleveland, O.
Saunders, D., Sons, Yonkers, N. Y.
Sloan & Chace Mfg. Co., Newark, N. J.

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Classified Index to Advts. (Continued).

Thermit.
Goldschmidt Thermit Co., New York.

Thread Cutting Tool.
Rivett Dock Co., Brighton, Mass.

Thrust Bearings.
Ball Bearing Co., Philadelphia, Pa.
Standard Roller Bearing Co., Philadelphia, Pa.

Tools.
Hammacher, Schlemmer & Co., New York.
Montgomery & Co., New York.

Tool Holders.
Armstrong Bros., Tool Co., Chicago, Ill.
Beaman & Smith Co., Providence, R. I.
O. K. Tool Holder Co., Shelton, Conn.
C. P. Mingst, Evansville, Ind.
Western Tool and Mfg. Co., Springfield, O.

Tool Racks.
New Britain Mch. Co., New Britain, Conn.

Tool Steel.
Boker, Hermann, & Co., New York and Chicago.
Heller Bros., Newark, N. J.
Wm. Jessop & Sons, Ltd., New York.

Tote Boxes.
Geauga Mfg. Co., Painesville, O.
Kilbourne & Jacobs Mfg. Co., Columbus, O.

Tracks, Trolley and Overhead.
Coburn Trolley Track Mfg. Co., Holyoke, Mass.
Yale & Towne Mfg. Co., New York.

Trolleys.
Yale & Towne Mfg. Co., New York.

Transmission Machinery.
Link Belt Engineering Co., Philadelphia, Pa.
Reeves Pulley Co., Columbus, Ind.
Speed-Changing Pulley Co., Indianapolis, Ind.

Trimmers, Wood.
Fox Mch. Co., Grand Rapids, Mich.

Tubing.
Standard Welding Co., Cleveland, O.

Turnbuckles.
Merrill Bros., Brooklyn, N. Y.

Turret Machinery.
American Turret Lathe Mfg. Co., Warren, Pa.
Bullard Mch. Tool Co., Box 1051, Bridgeport, Conn.
Fay & Scott, Dexter, Me.
Gisholt Mch. Co., Madison, Wis.
Hendey Mch. Co., Torrington, Conn.
Jones & Lamson Mch. Co., Springfield, Vt.
Warner & Swasey Co., Cleveland, O.

Universal Joints.
Baush Mch. Tool Co., Springfield, Mass.
Gray & Prior Mch. Co., Hartford, Conn.
Vanderbeek Tool Wks., Hartford, Conn.

Valves.
Crane Co., Chicago, Ill.
Garry Iron & Steel Co., Cleveland, O.
Jenkins Bros., New York.

Vises.
Armstrong Mfg. Co., Bridgeport, Conn.
Athol Mch. Co., Athol, Mass.
Carter & Hakes Mch. Co., Winsted, Conn.
Emmert Mfg. Co., Waynesboro, Pa.
Graham Mfg. Co., Providence, R. I.
Howard Iron Works, Buffalo, N. Y.
Jacobson Mch. Mfg. Co., Warren, Pa.
Merrill Bros., Brooklyn, N. Y.
Montgomery & Co., New York.
Prentiss Vise Co., New York.
Reed Mfg. Co., Erie, Pa.
Vanderbeek Tool Wks., Hartford, Conn.
Wyman & Gordon, Worcester, Mass.

Watchman's Clock.
Waggoner Watchman Clock Co., Grand Rapids, Mich.

Welding.
Goldschmidt Thermit Co., New York.
Standard Welding Co., Cleveland, O.

Winches.
Yale & Towne Mfg. Co., New York.

Wire Nail, Washer, Etc.
Acme Mchy. Co., Cleveland, O.
National Mchy. Co., Tiffin, O.

Wire Working Machinery.
Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.
Waterbury-Farrel Fdy. & Mch. Co., Waterbury, Conn.

Wood Boring Machines, Pneumatic.
Rand Drill Co., New York.

Wood Working Machinery.
Fox Mch. Co., Grand Rapids, Mich.

Wrenches.
Armstrong Mfg. Co., Bridgeport, Conn.
Billings & Spencer Co., Hartford, Conn.
J. M. Carpenter Tap & Die Co., Pawtucket, R. I.
Coes Wrench Co., Worcester, Mass.
Eaton, Cole & Burnham Co., New York.
Keystone Drop Forge Wks., Chester, Pa.
Montgomery & Co., New York.
Reed Mfg. Co., Erie, Pa.
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For Alphabetical Index, see Page 24.

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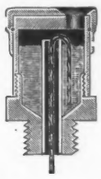

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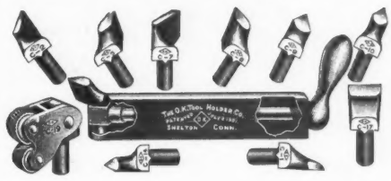

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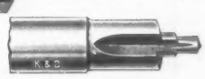
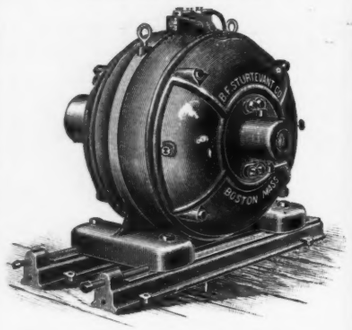


Prices for a Postal

KENDRICK & DAVIS, LEBANON, N. H.

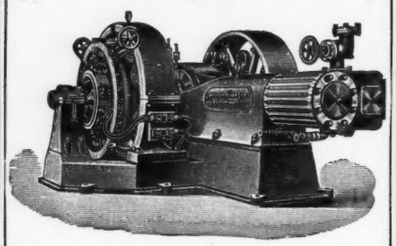
STURTEVANT

Motors



All types and sizes from ¼ to 125 h. p. to meet any requirement.

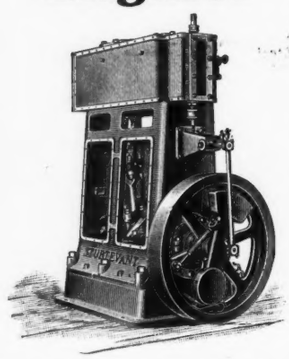
Generating Sets



All types and sizes between 1½ and 250 k. w.

We build both engine and generator.

Engines



Over 100 types and sizes from 2 to 400 h. p., horizontal and vertical.

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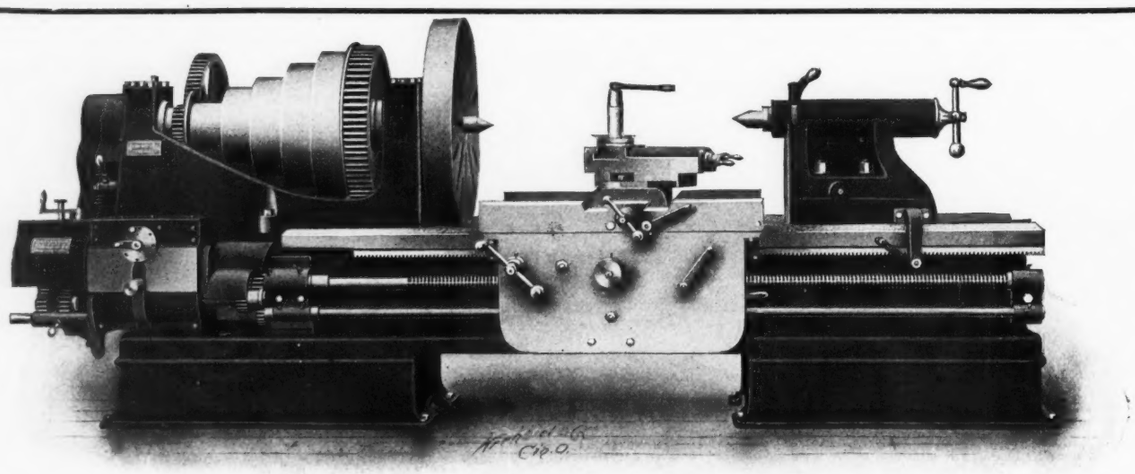

30-in. Instantaneous Change Gear Engine Lathe

Any pitch or feed being instantly obtainable without removing a gear, as shown in the index. This Lathe is made either Back or Triple Geared.

TOP INDEX HANDLE IN HOLE	CUTS	FRONT INDEX HANDLE IN HOLE							
		1	2	3	4	5	6	7	8
1	Threads per inch	1	1 1/8	1 1/4	1 3/8	1 7/16	1 1/2	1 5/8	1 3/4
2	" " "	2	2 1/4	2 1/2	2 3/4	2 7/8	3	3 1/4	3 1/2
3	" " "	4	4 1/2	5	5 1/2	5 3/4	6	6 1/2	7
4	" " "	8	9	10	11	11 1/2	12	13	14

FEEDS 5 TIMES THREADS PER INCH.

W. T. EMMES' PATENT, AUG. 26, 1902, OCT. 28, 1902.

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High Grade; All Improvements; Rapid, Accurate, Economical. Full line includes:

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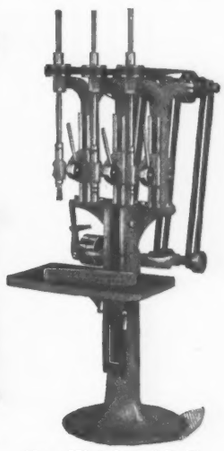
No. 4 A. The Popular Bench Size

CATALOGUES MAILED ON REQUEST.

No. 5 Heavy Tube or Pipe Machine



No. 3 High Speed Drill

Fox Machine Company, 815-825 North Front Street, Grand, Rapids, Michigan

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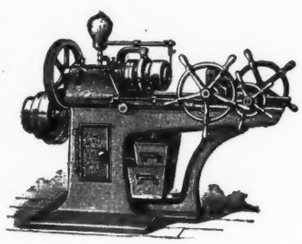

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INCLUDING

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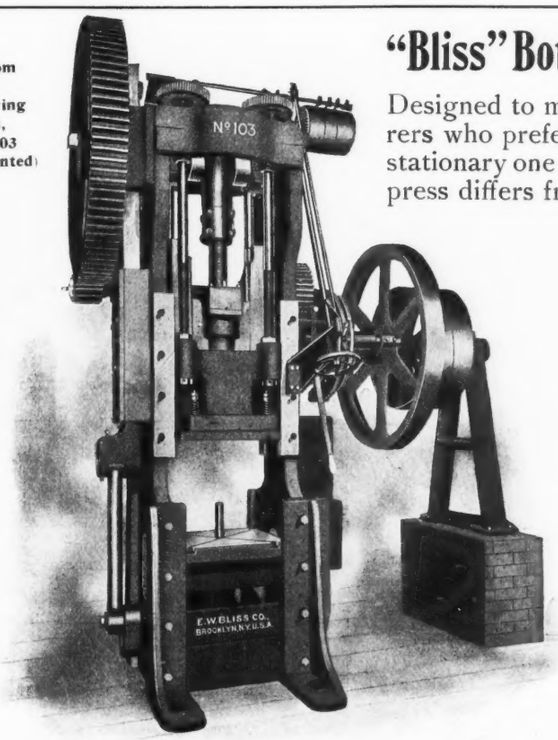
NATIONAL MACHINERY CO., TIFFIN, OHIO, U. S. A.

Bottom Slide Drawing Press, No. 103 (Patented)



"Bliss" Bottom-Slide Drawing Press, No. 103

Designed to meet the requirements of certain manufacturers who prefer a press with movable bed in place of the stationary one adopted in our other drawing presses. This press differs from other bottom-slide drawing presses in having the *main working parts overhead*, a great advantage, especially where machines are crowded together. The bed is so counterbalanced that the counterweight may be varied to compensate for different weights of dies. The long range of adjustment permits of unusual die space and the use of long inside-blank holders. The toggles beneath the bed transfer the strain of blank-holding to the frame of the machine, leaving the shaft free for drawing, and are operated by a cam on the main gear, timed to the best advantage, enabling operator to easily remove the drawn shells and place new blanks under the dies while working to full capacity of press.

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Stiles & Parker Press Co.
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European Office, 4 Rue Huntzinger, Clichy pres Paris, France.

Distributing Agents for Chicago and Vicinity: Stiles-Morse Co., 65 West Washington Street, Chicago Ill.
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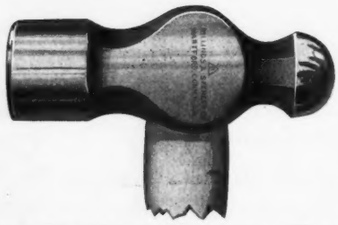
There is Satisfaction in the use of a Good Tool.



We again bring to your notice our New Drop Forged Octagon Pattern Machinist's Hammers. They cannot fail to satisfy you in every particular. The Handles are made of clear, thoroughly seasoned Hickory turned and fitted at our works. Forgings are of Special Hammer Steel and Sides, Faces and Peins are polished.

Every Hammer bears our Trade (B) Mark and is fully warranted.

IT PAYS TO GET THE BEST. CIRCULAR H-B.

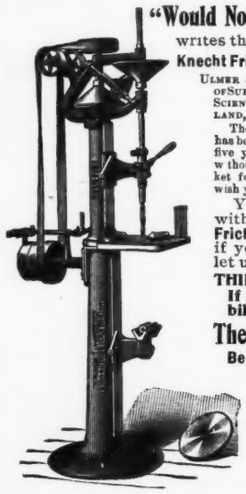
The Billings & Spencer Co., Hartford, Conn, U.S.A.

Makers of Drop Forgings of every Description.

"Would Not Be Without It."

writes this firm about the

Knecht Friction Sensitive Drill.



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The Knecht Friction Drill Press has been in constant use for over five years, and we would not be without it. You should find market for all you can make. We wish you success.

You would not be without the **"Knecht Friction Sensitive"** either if you used it once, so let us send one on

THIRTY DAYS' TRIAL.

If it does not fill the bill send it back.

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A complete line from 21 to 42 inch swing, strictly high grade machines, embodying the very best of material, workmanship and finish; perfect in design and absolutely ahead of every other make for reducing cost and producing profits.

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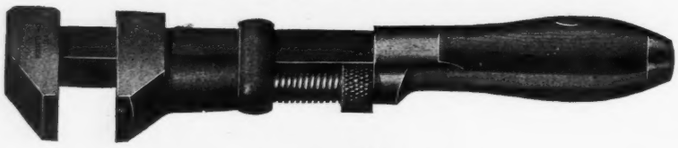

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H=Hydraulic Machinery.
L=Spinning Lathes, Edging Lathes, etc.
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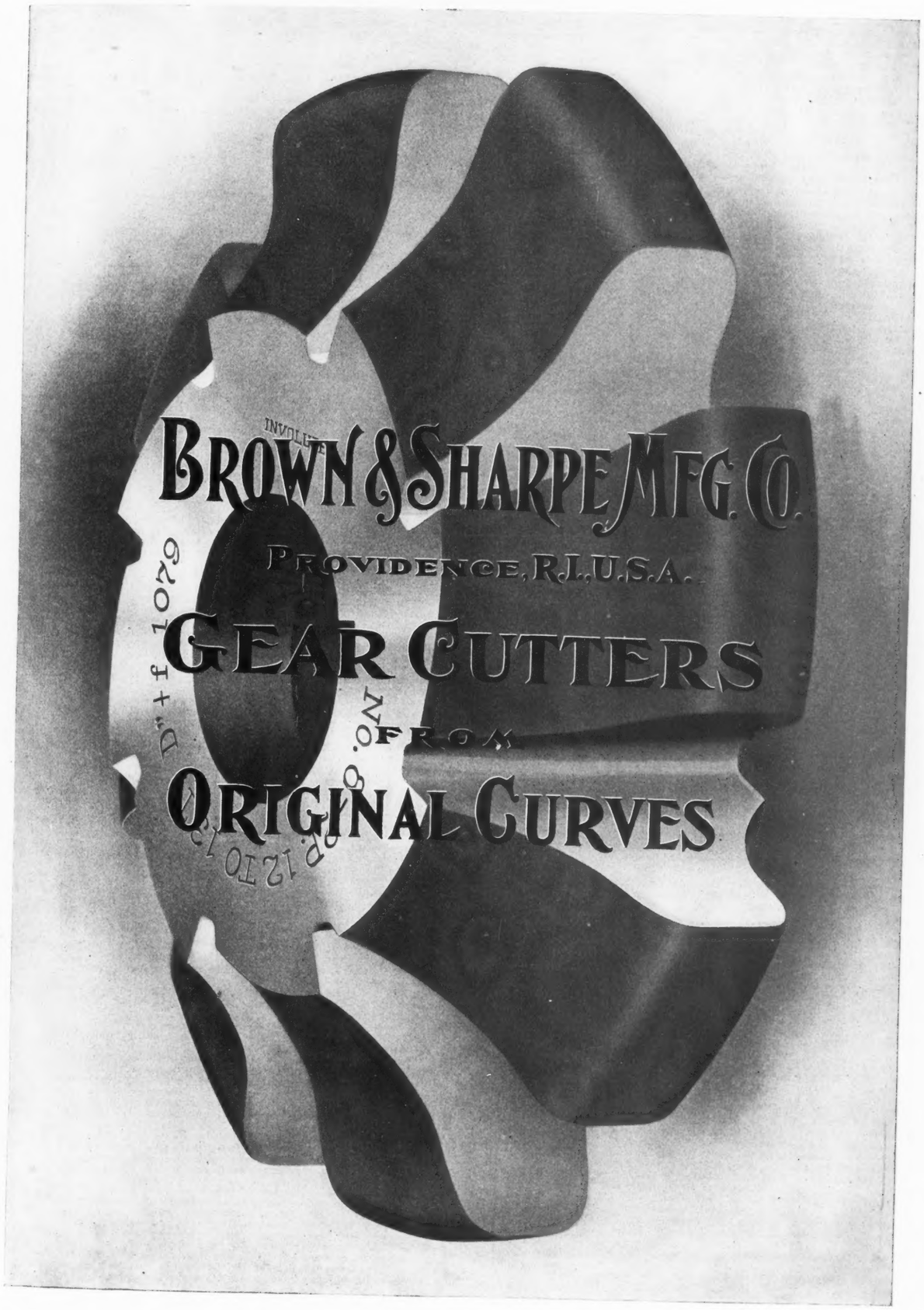
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ORIGINAL CURVES

to manufacture in America, retaining the Swiss company as consulting engineers. They inform us that they are putting on the market alternating-current generators, transformers and accessories of perfect design and construction, adapted to American practice, and opportunities to bid on this apparatus are invited.

THE RAND DRILL CO., 128 B'way, New York, have been awarded the contract for furnishing two large compressors to be used in the Central Air Power Plant, eighteen miles below Sault Ste. Marie. They will supply air to operate 25 Little Giant rock drills, 4 three-ton cableways and 4 large water pumps. Their combined capacity is 6,600 cubic feet of free air per minute. The work in hand is for constructing and dredging a two-mile channel in the Soo River, wide and deep enough for the navigation of large vessels.

THE HARTFORD BLOWER CO., INC., 120 Suffield Street, Hartford, Conn., are rushed with orders, being obliged to work overtime and having increased their plant and the number of their employees. Among large orders lately received are: Three 160-inch fans and 24 heaters for the Eastern Tanners' Glue Co., two large "Hartford" mechanical dust-collecting systems for Wm. A. Rogers, Ltd.; 10 large heaters for the Hillman Tobacco Curer Co., and a "Hartford" mechanical dust-collecting system for the Elm City Lumber Co.

THE MARVIN & CASLER CO., Canastota, N. Y., is the new name of the concern formerly known as Marvin & Casler, engaged in the manufacture of machinery. The directors for the ensuing year are H. N. Marvin, president; H. Casler, treasurer, and L. R. Cooper, secretary and manager. Their factory has been enlarged and new machinery added, increasing their facilities. They state that they are especially equipped for the manufacture of machines in quantities with interchangeable parts.

ROBERT GRIMSHAW, Wambuchenstrasse 9, Hanover, Germany, has sent us a sample of the 45-degree "Kavalier" perspective sketch cards (legally protected) for machine shops, patent agents, etc., which he has brought out. For those preferring the 120-degree isometric perspective (the measurements of which are the same at the principal axes), he offers an isometric linear card (legally protected also). For beginners, those studying and requiring sketch cards, etc., he has an isometric 145-degree sketch paper, with printed text.

THE JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J., are sending out a card calling attention to the difficulty of properly lubricating the air cylinders of air compressors with oil, and the danger attendant to the use of low flash-point lubricating oil; a number of bad receiver explosions have been traced to the use of such oils, which generate explosive vapors. With graphite the cutting and grinding of the cylinders is stopped and the supply of oil may be greatly reduced, which is desirable even if high-grade oil is employed.

THE HART MFG. CO., Cleveland, O., inform us that their representative at Yokohama, Japan, has been much annoyed recently by postal requests for catalogues received from the Sumidayen Co., 17 Tatami Street, Tokyo. This concern is engaged in the collection of old books, postage stamps, etc., and they make it a practice to secure catalogues from American manufacturers for the purpose of selling same, in which it appears they have been quite successful. The Hart Company request us to publish this item as a warning to manufacturing concerns.

THE CANADIAN RAND DRILL CO., Sherbrooke, Que., recently closed with the Canadian Westinghouse Co., of Hamilton, Ont., for the installation of a "Rand-Corliss" compound, power driven, air compressor, to be installed in their new plant. This machine is designed to furnish air for the various pneumatic appliances throughout the works and is to be driven by a Westinghouse motor through a Morse chain drive. The International Coal & Coke Co., Coleman, Alberta, have just placed an order with the Canadian Rand Drill Co. for a 300 horse power, steam driven, Rand duplex compressor of the very latest type.

MANNING, MAXWELL & MOORE, New York, have secured a large order amounting to between $150,000 and $160,000 worth of tools from the Illinois Central Railroad, to be shipped to the various shops along their lines. The order consists of a full line of railroad tools. They have also secured the following orders: All the electric traveling cranes required for the various shops of the Illinois Central Railroad; a large order from one of the Government powder depots; a number of orders from various navy yards on the eastern and Pacific coasts; a large order for the shops of the Central Railroad of New Jersey; and several orders for an assortment of machine tools going to some of the Western railroads.

THE WILMARTH & MORMAN CO., Grand Rapids, Mich., report the receipt of the following orders recently, for their "New Yankee" drill grinders: Louisville & Nashville R. R. Shops, Louisville, Ky.; Woodmanse Mfg. Co., Freeport, Ill.; Tabasco-Chiapas Trading and Transportation Co., Tabasco, Mex.; Diamond Chair Co., Chico, Cal.; Morrison Mfg. Co., Fort Madison, Ia.; Rome Brass and Copper Co., Rome, N. Y.; Duluth St. Ry. Co., Duluth, Minn.; Scott & Oliver Mfg. Co., Knoxville, Tenn.; Hersey Mfg. Co., Boston, Mass.; Redwoods Mfg. Co., Black Diamond, Cal.; Pittsburg Valve, Fdy. and Construction Co., Pittsburg, Pa.; Atlantic Coast Line R. R. Co., Wilmington, N. C.; J. F. W. Dorman Co., Baltimore, Md.; U. S. Navy Yard (League Island), Pa.; Russell, Burdsall & Ward Bolt and Nut Co., Port Chester, N. Y. Also one grinder to Holland, two to Canada, three to Russia, etc.

SUMMARY OF NEW TOOLS, CATALOGUES, ETC.

IN THIS NUMBER.

MACHINERY describes in each number more new tools and appliances than any other mechanical paper, and a glance over this column will enable the reader to pick out what is of special interest to him.

	Page
CENTERING MACHINE: Hendey Machine Co., Torrington, Conn. QUICK CHANGE DEVICE, FOR ENGINE LATHES: New Haven Mfg. Co., New Haven, Conn. GRINDER, PORTABLE ELECTRIC: Hisey-Wolf Mche. Co., Cincinnati, O. LATHE, HIGH-SPEED: Lodge & Shipley Mche. Tool Co., Cincinnati, O. FOUNDRY RIDDLE: Adams Co., Dubuque, Ia. ELECTRIC PUMP, HIGH-SPEED: Blake & Knowles Steam Pump Wks., New York MILLING MACHINE: Owen Mche. Tool Co., Springfield, O. UNIVERSAL GRINDER: Walker Grinder Co., Worcester, Mass. ELECTRIC TRAVELING HOIST: Maris Bros., Philadelphia, Pa. SCREW THREAD GENERATING MACHINE: Newton Mche. Tool Wks., Philadelphia, Pa.	679 680 681 682 685
CATALOGUES.	
ELECTRICAL SUPPLIES: The F. Bissell Co., Toledo, O. "RENOLD" SILENT CHAIN: Link-Belt Engineering Co., Philadelphia, Pa. TOOL HOLDER, "O. K.": O. K. Tool Holder Co., Shelton, Conn. EMERY AND CORUNDUM WHEELS: Star Corundum Wheel Co., Ltd., Detroit, Mich. MARKING CRAYONS: D. M. Steward Mfg. Co., Chattanooga, Tenn. ELECTRIC MOTORS: Northern Electric Mfg. Co., Madison, Wis. OILSTONES: Pike Mfg. Co., Pike, N. H. ENGINES AND BOILERS: Wickes Bros., New York. SCREW MACHINES: National Acme Mfg. Co., Cleveland, O. WELDING COMPOUND, "THERMIT": Goldschmidt Thermit Co., Wall St. Exchange Bldg., New York MACHINE TOOLS: Garvin Mche. Co., New York. DRILLING MACHINES: Thos. H. Dallett Co., Philadelphia, Pa. FRICTION CLUTCHES: Carlyle Johnson Mche. Co., Hartford, Conn. ELECTRIC-DRIVEN GRINDERS AND DRILLS: Hisey-Wolf Mche. Co., Cincinnati, O. CHUCKS: Hoggson & Pettis Mfg. Co., New Haven, Conn. MACHINE TOOLS: B. F. Barnes Co., Rockford, Ill. PRECISION TOOLS: Massachusetts Tool Co., Greenfield, Mass. TWIST DRILLS, REAMERS, ETC.: Cleveland Twist Drill Co., Cleveland, O. CENTRIFUGAL PUMPS: Henry R. Worthington, New York. PNEUMATIC HAMMERS: Ingersoll-Sergeant Drill Co., New York. AIR COMPRESSORS: Ingersoll-Sergeant Drill Co., New York.	686

MISCELLANEOUS.

Advertisements in this column, 25 cents a line, ten words to a line.

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PATENTS.—H. W. T. Jenner, patent attorney and mechanical expert, 608 F Street, Washington, D. C. Established 1883. I make an examination free of charge and report if a patent can be had and exactly how much it will cost. Send for circular. Member of Patent Law Association.

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WANTED.—Complete equipment of machinery for a machine shop. Address with particulars—"NEW SHOP," care MACHINERY, 66 W. Broadway, New York.

WANTED.—Copies of numbers 7 and 8 of MACHINERY, Volume 9. Address, with price. THE INDUSTRIAL PRESS, 66 West Broadway, New York.

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WANTED.—One machinist or draftsman in each shop to have a free copy of this new course of instruction in Gasoline Engines, Motor Carriages, Boat Machinery, and Aerial Motors. Just out. The largest and most complete publication of its kind in the world. Including twenty-eight sheets of blue prints, free consultation, sketching and expert advice on your own problems. This is your opportunity. Prospectus free to any one. Send for it. S. M. HOWELL, M. E., Zanesville, Ohio.

WANTED.—Positions for reliable engineers, draftsmen, foremen and superintendents. Good men wanted to register. CLEVELAND ENGINEERING AGENCY, Station B, Cleveland, Ohio.

WANTED.—Superintendent to take charge of the manufacture of gas engines on a large scale for a company just commencing the manufacture of gas engines; must be thoroughly familiar with the details of manufacturing gas engines in every respect; must have thorough, practical experience on gas engines; of good character; good organizer. Must have tact and ability to handle men to the very best advantage; technical education not absolutely necessary; need not be a designer. Best of references must be furnished. To the right man a good position. Address GAS ENGINES, care MACHINERY, 66 W. Broadway, New York.

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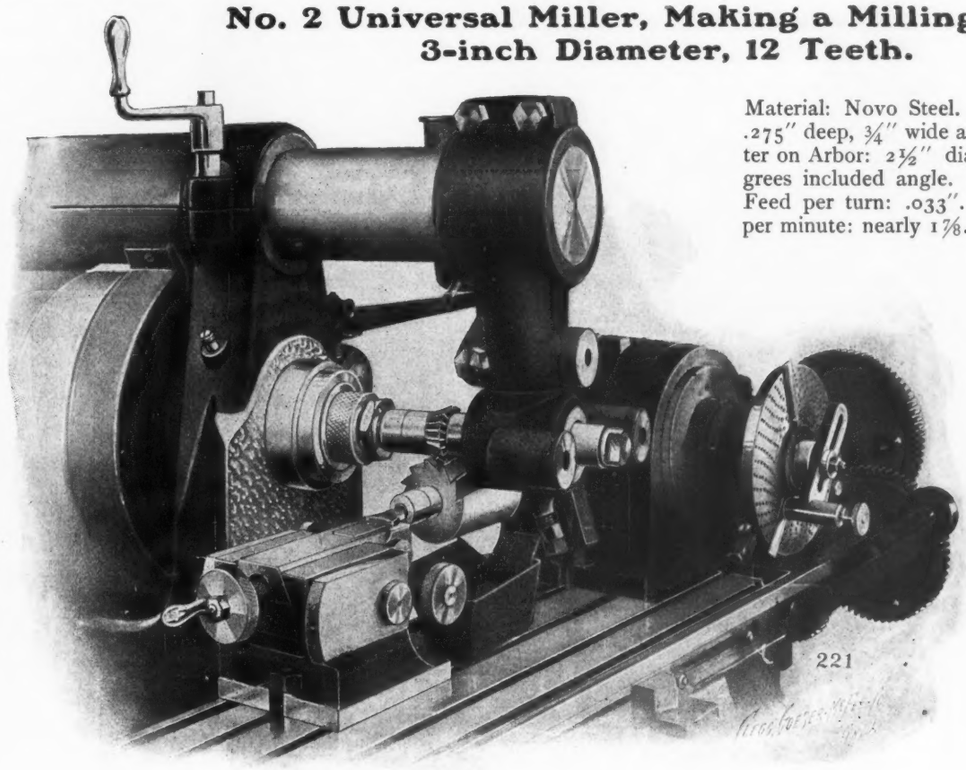

Material: Novo Steel. Size of Cut: .275″ deep, ¾″ wide at the top. Cutter on Arbor: 2½″ diameter, 80 degrees included angle. R. P. M.: 56. Feed per turn: .033″. Table travel per minute: nearly 1⅞.

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The chances are, that it doesn't—there are many such. The fault is usually in the tools. You cannot expect your toolmaker to get "modern" results out of a miller that was bought 12 or 15 years ago and is "still good", nor out of a newer machine of the "cheaper-but-just-as-good" kind. Try it yourself. This illustration shows modern practice. It is one of our every day jobs, and shows the sort of work for which our No. 2 Universal Miller is especially adapted. It does this quietly without any tendency to chatter, finishing each tooth at a single, smooth, clean cut. If you have a stiff machine with a powerful Dividing Head like the "Cincinnati", such results are easily obtained. Let us tell you more about it.

1904 Louisiana Purchase Exposition.—Our electrically-driven Millers may be seen in the exhibits of the Westinghouse Electric & Mfg. Co., Northern Electrical Mfg. Co., Western Electric Co.

We will be pleased to submit time estimates with suggestions for milling your work.

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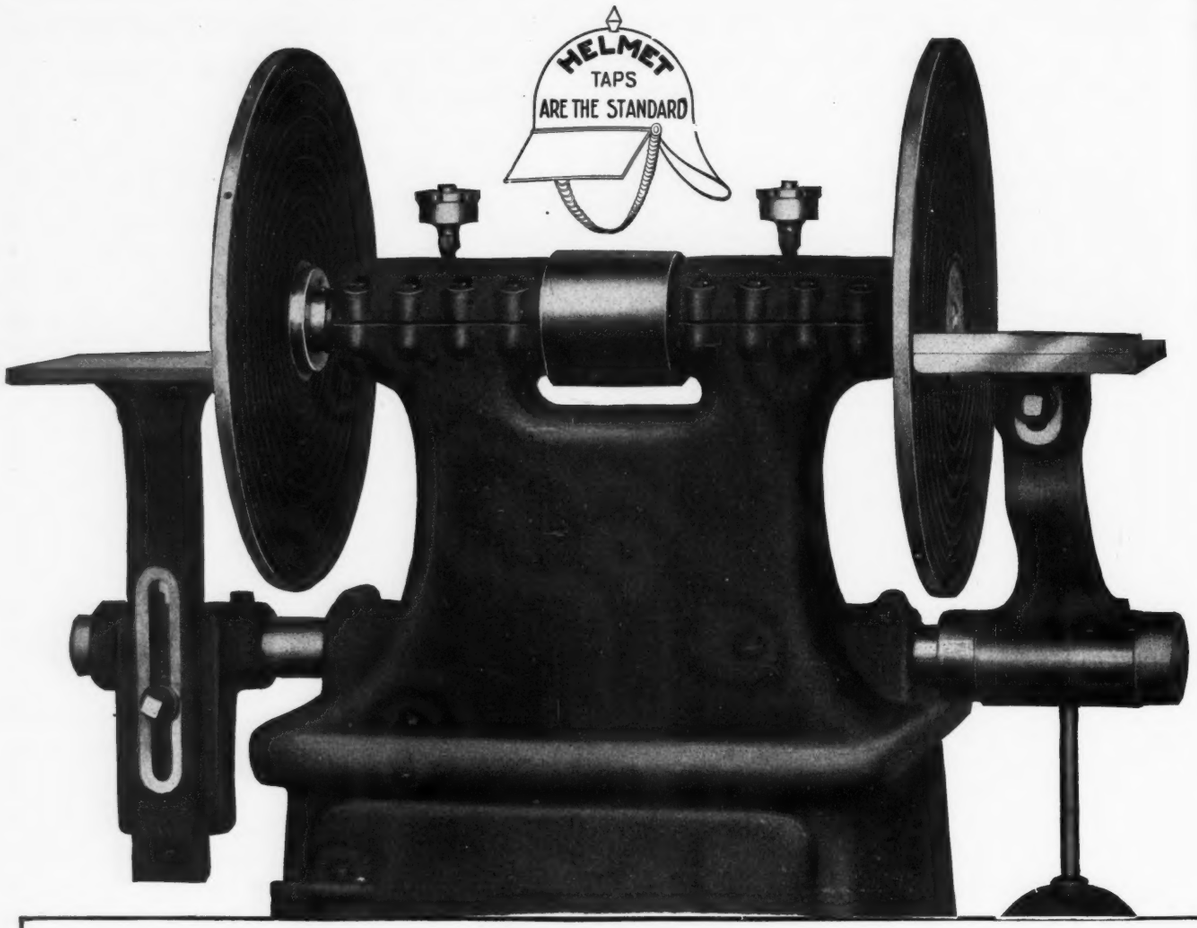

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There is a practical lesson in economy here—does it apply to your case?

The Gardner Grinder with special grooved discs saves 50% on all flat grinding. Send us a sample of your work and let us try it on the Gardner; we will finish and return it free of charge, marking the time required, composition used on spiral circle and the size machine on which it was done.

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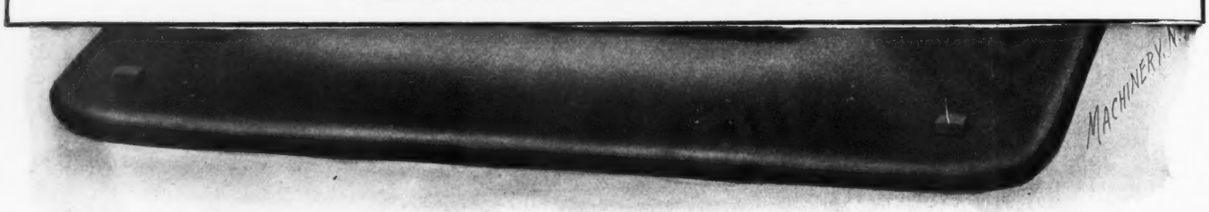

FOR YOUR CONVENIENCE

IN ORDERING CIRCULARS AND CATALOGS, also to give you a BETTER IDEA OF THE EXTENT AND SCOPE OF OUR LINES, we append herewith an alphabetical list of catalogs and circular matter which we issue.

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Benches, Carpenters, etc.....M184
Blocks, Shelf M102
Bolts, Stove .....M 64
Box Trimmings M118
Brushes, Glue and Varnish .....M 93
Builders' Hardware M145
Burrs and Rivets M229
Butts, Wrought Steel and Brass (lists)....M219

Cabinet Hardware M151
Cabinet Trimmings (fancy) M192
Card Frame Pulls M172
Carpet Layers' Tools M132
Casters, All Kinds M128
Catches, Friction No. 90 .....M220
Catches, Violin Box M182
Chair Cane M195
Chair Seats, Leather and Imitation M164
Chair Seats, Wood Perforated M201
Chair and Stool Screws and Spiders.....M108
Chests, Tool M230
Clamps, Hand Screw, etc.....M185
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Emery (Washington Mills) M152

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Glass Knobs .....M171 & 200
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Hardware, Fancy Brass Trimmings, etc....M192
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Salts, Soldering (Yager's) M205
Saw Table, Pierce's Patent (Industrial)....M155
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Saws, Band (French Imported).....M183
Seats, Chair, Leather and Imitation.....M164
Seats, Chair, Wood Perforated.....M201
Seats, Chair, Tufted M181
Screwdrivers, Mann's Patent "Hold Fast"..M193
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Screws, Set (New Hollow).....M228
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Splitting Paper (Sandpaper) M134

Tacks, Twine, etc. .....M 52
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Tools, Carpet Layers' and Upholsterers'....M132
Tools, Clay Modeling and Plaster Carving..M212
Tools, General Catalogue M180
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Tools for Venetian Bent Iron Work.....M189
Tools for Wood Carvers.....M187

Upholsterers' and Carpet Layers' Tools....M132
Upholsterers' Nails (Gilt, Fancy Heads)....M156

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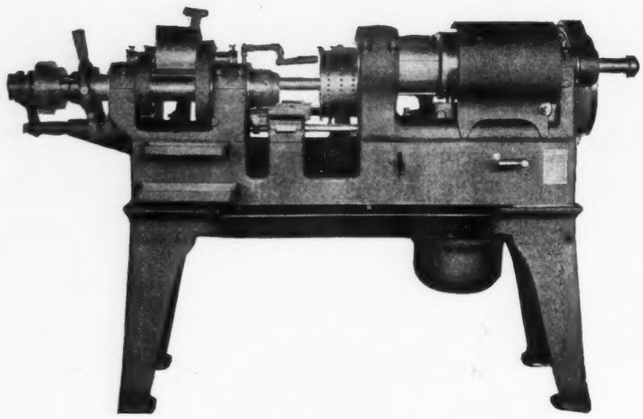

It would take so long to enumerate all that *can* be accomplished on a Cleveland Automatic Screw Machine that the simpler way would be to state what *can't* be done—

Suffice it to say the "Cleveland" will produce automatically pieces of all shapes and sizes from castings, forgings or the bar and effect a saving in cost ranging from 200 to 500 per cent. That the "Cleveland" is built for all kinds of work from the simplest to the most complicated, to handle almost any material, and to save an incalculable amount of time, labor and trouble. If you are interested in producing multiple parts rapidly, accurately and economically send us samples or blueprints of the work you are doing; we will estimate the cost of turning it out on our machines and return the sample with our figures—it will cost you nothing and may mean a good deal for the future.

We show a few examples of work done on Cleveland Automatics.

The Cleveland Automatic Machine Company

CLEVELAND, OHIO, U. S. A.

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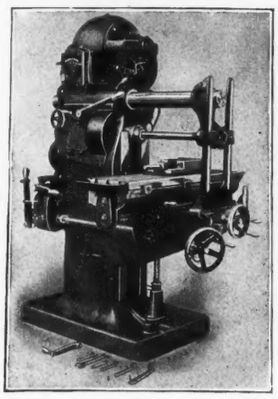
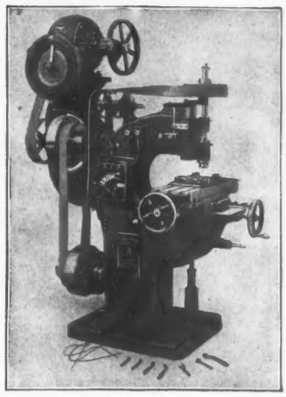


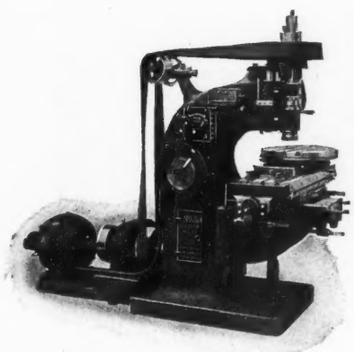
No. 3 Gear Feed
Plain Milling Machine

Visit Our Exhibit

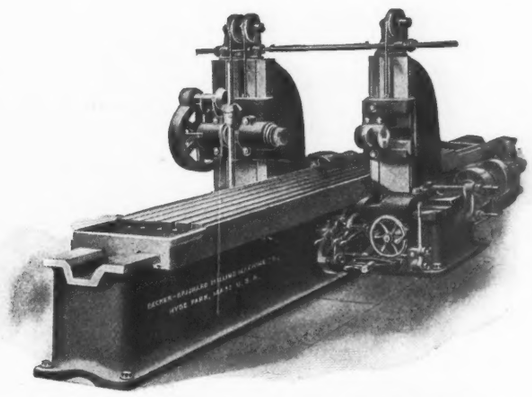
Block 13, Machinery Hall, Louisiana Purchase Exposition comprising machines shown herewith, also cutters for use with same



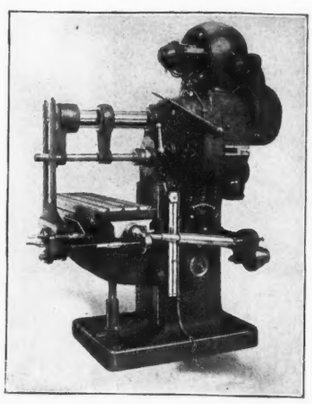
No. 3 Vertical
Milling Machine



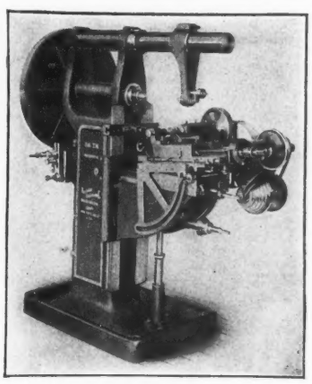
No. 5-B Vertical Milling Machine



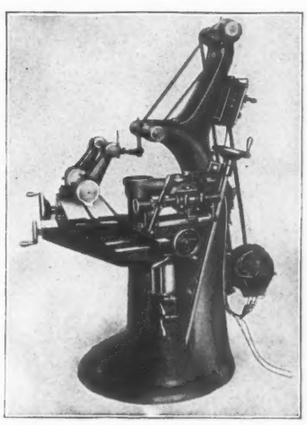
26″ x 32″ x 10 ft. Planer-type Milling Machine



No. 5-B
Plain Milling Machine



36″
Automatic Gear Cutter

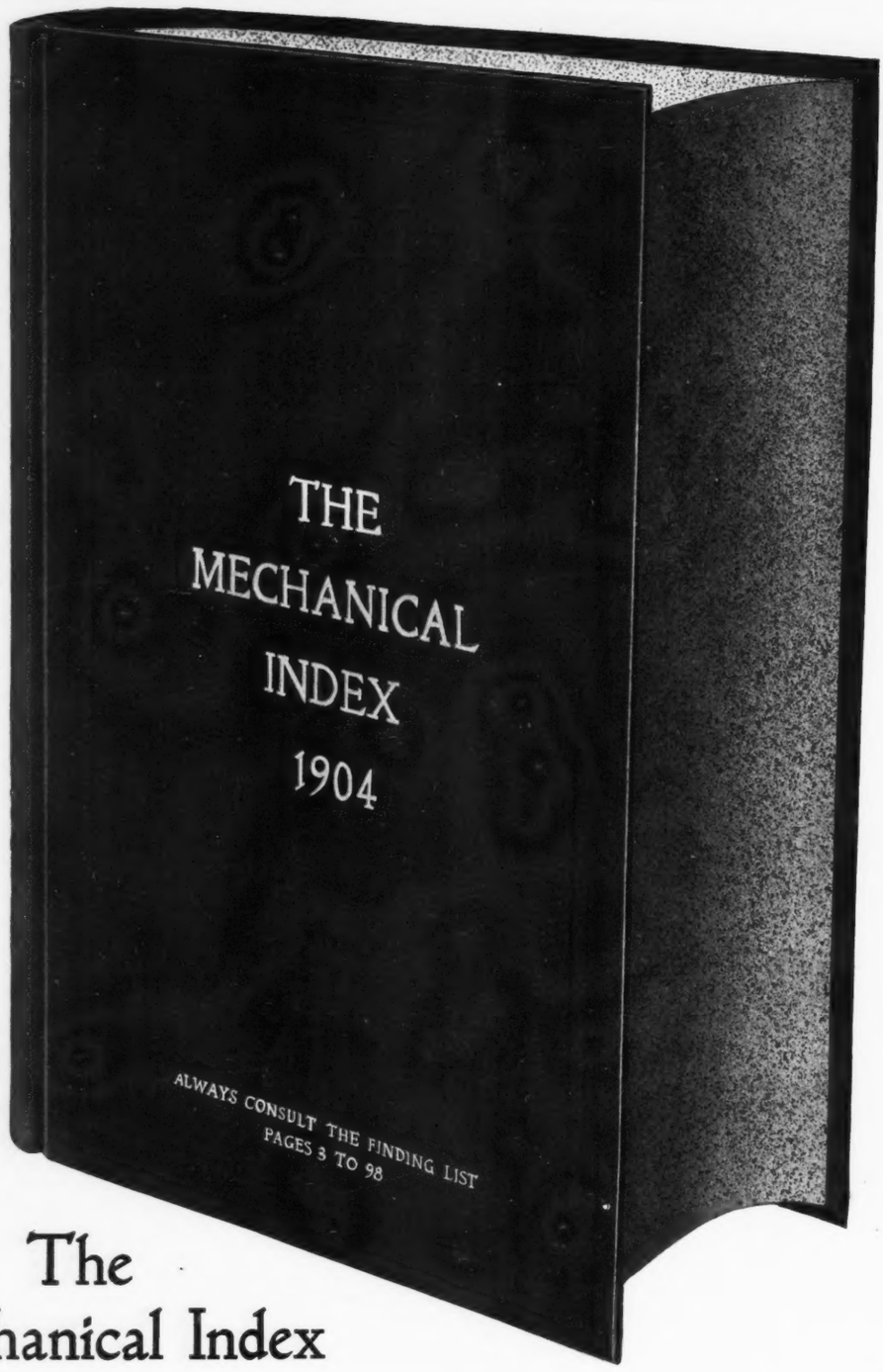


No. 1—14″
Cutter and Reamer Grinder

BECKER-BRAINARD MILLING MACHINE CO.

HYDE PARK, MASSACHUSETTS

Branch Office, The Bourse, Philadelphia, Pa.



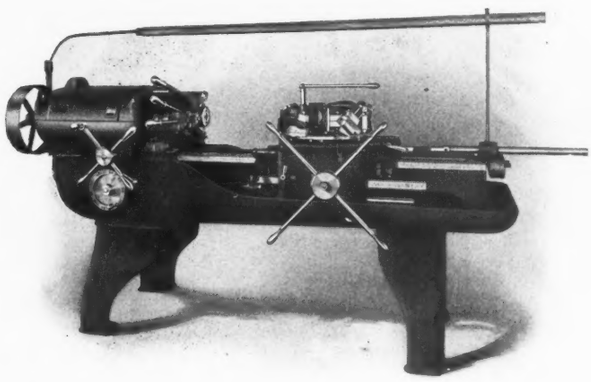
The Mechanical Index

not only includes a complete list of all manufacturers of mechanical appliances in the United States, but gives a concise explanation of the use for which each appliance is intended. It does not include branch offices, nor agencies of manufacturers, nor dealers. Gives the headquarters address of every manufacturer under exactly the right heading, and classifies the whole so as to save the time of its users.

Bound in Cloth. 1053 pages. Price, $7.50 Delivered.
Sample Sheets on request.

The Industrial Press, Publishers, New York City.

Where there is one Flat Turret Lathe, there is soon use for more



Unquestionably the Flat Turret Lathe is the best machine made for the rapid production of duplicate lathe work up to 3 inches in diameter and 36 inches in length. It can also be used for a variety of chucked work up to 14 inches in diameter and of almost any shape, and will assure a saving varying from 50 to 80 per cent. with 70 per cent. as a safe average. Recent changes in the design of the Flat Turret Lathe have widened its range of usefulness and rendered it of even greater value to the shop that aspires to the maximum output at the minimum cost. The Flat Turret is now built in two sizes, 2x24 and 3x36, has cross feeding head, single drive, all feeds and speeds instantly obtainable and other advantageous features that are fully described in our new catalogue.

We shall be glad to send a representative to explain the machine and estimate what can be saved on your work. It will place you under no obligation to us, and may be to your advantage.

Jones & Lamson Machine Company

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Machinery N.Y.

FINN *the* FOREMAN *says:*

3

Now, here's a thing I wouldn't believe, if you had told me, but I was master mechanic of the road myself, when it happened.

This is a section of a New Process Raw Hide Electric Railway Pinion. It ran 23,000 miles on an old double reduction motor—without a gear-case, mind you—through mud, slush and water—carrying 20-foot cars up grades from 6 to 12 per cent. And they only took it out because the armature failed. Just look at it—not a tooth stripped. And the pinion wasn't worn out by a long shot.

How's that for the **wearing** qualities of New Process Raw Hide? Ordinary raw hide wouldn't have done it. I tell you, **it wears like iron!** Perhaps their free booklet will help you.

TRADE N.P.R.H. MARK REGISTERED.

MW

THE NEW PROCESS RAW HIDE CO.
SYRACUSE, N.Y.

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Very truly yours,
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STARRETT TOOLS are the Standard for accuracy, workmanship, design and finish.

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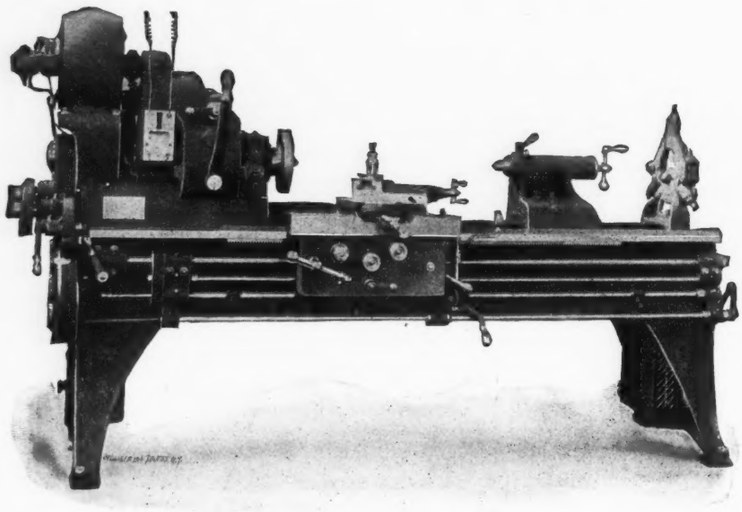


16-inch "Ideal" Engine Lathe, with Motor

No Makeshift Methods

or penny-wise devices were embodied in the equipment of the "Ideal" Engine Lathe for motor drive—the lathe was practically redesigned as a motor tool, the projections for carrying the motor as well as the bearings for the extra shaft being cast intergral with the headstock. The motive power is furnished by a 1½ H.P. Northern Electrical Mfg. Co.'s motor with a speed of 600 to 1200 revolutions per minute, regulated by a conveniently arranged controller, and giving the lathe the wide range of speeds demanded by present day practice.

The Motor Driven 14", 16" and 18" "Ideal" Lathes possess the same advantageous features as our regular belt driven machine, including: *Patented Rapid Gear Changing Device, Friction-geared Head Spindle,* Reverse motion at carriage, Automatic stop for turning and screw cutting, and is one of the most profitable machines for manufacturing or tool room work on the market. We build a full line of machine tools and shall be glad to send you catalogue.

Springfield Machine Tool Co., Springfield, Ohio

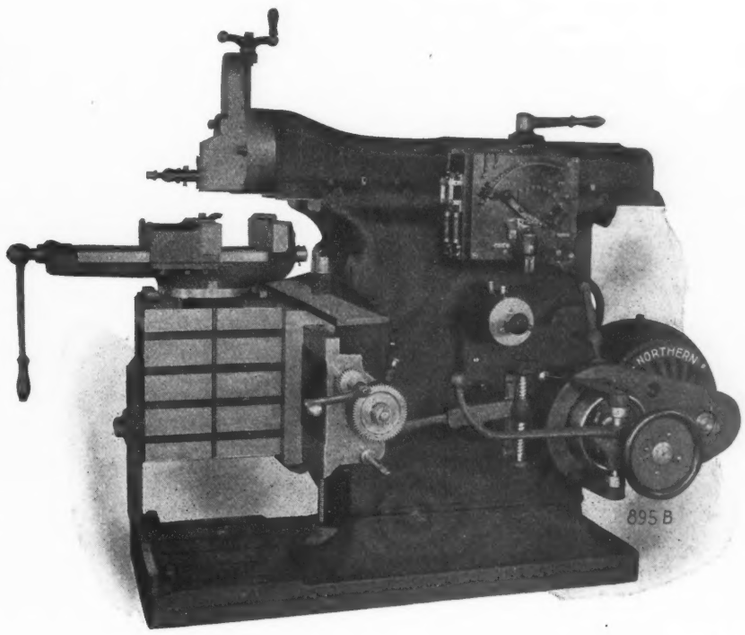
Manufacturers of Engine Lathes, Crank and Geared Shapers, Power Presses, Brass Finishing Lathes, Turret Lathes, Shafting Lathes, Chucking Lathes, Spindle and Axle Boring Machines. Also Iron Founders.

QUALITY COUNTS

No matter how spick and span and highly polished a machine may be, how many showy attachments it may have, or how many flowery testimonials to recommend it, if it isn't backed up by quality in material, construction, design—quality all through—it doesn't count much in the day's work. In Gould and Eberhardt Tools "Quality is the Keynote"—quality from the base to the last screw and every improvement, convenience and cost reducing feature combined with it

As an example of Quality, take the

Eberhardt Patent 24-in. Extension Base Shaper with Variable Speed Motor Drive



This machine has a range from 5 strokes per minute back geared to 100 strokes single geared, or any intermediate variation instantly obtained to suit the metal. Machine can be stopped instantly at any part of the stroke. All controlling handles within convenient reach of operator without leaving working position. No belts to shift. A powerful, durable Shaper, smooth cutting and designed to get the fullest benefit from the new "high duty" cutting steels.

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United States of America,

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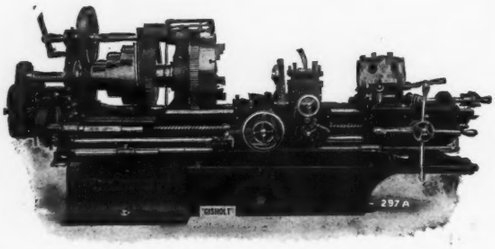

Gisholt Turret Lathes

A tool that will do any boring, facing and turning work that can be done on an engine lathe and at a saving of from one-third to one-half and upwards in actual time. Accurately finished pieces, not merely roughed out. Investigate these machines. We have adapted them for finishing many thousand different pieces of work, both chucked and from the bar. See us at the Fair, block 14, aisles F and 3, Machinery Building. Catalogue H for the asking.

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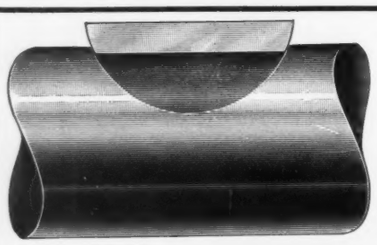
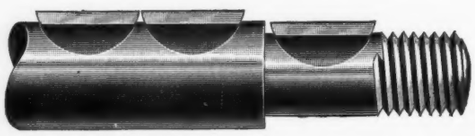
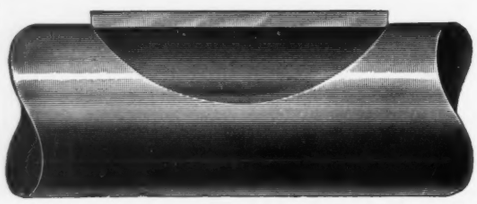
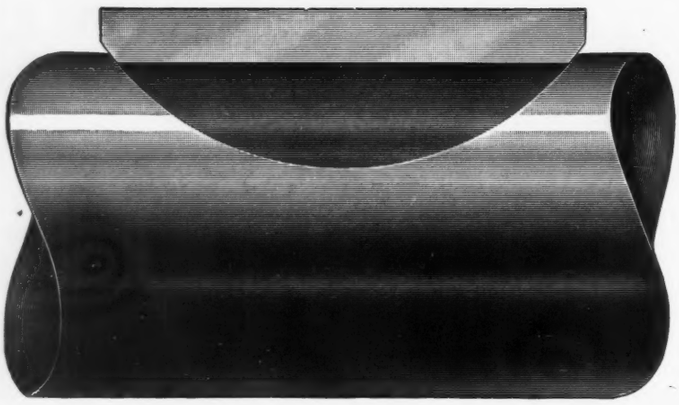




THE WOODRUFF PATENT SYSTEM OF KEYING



has been adopted by the leading manufacturers of machinery, automobiles, etc. There must be some reason for it.



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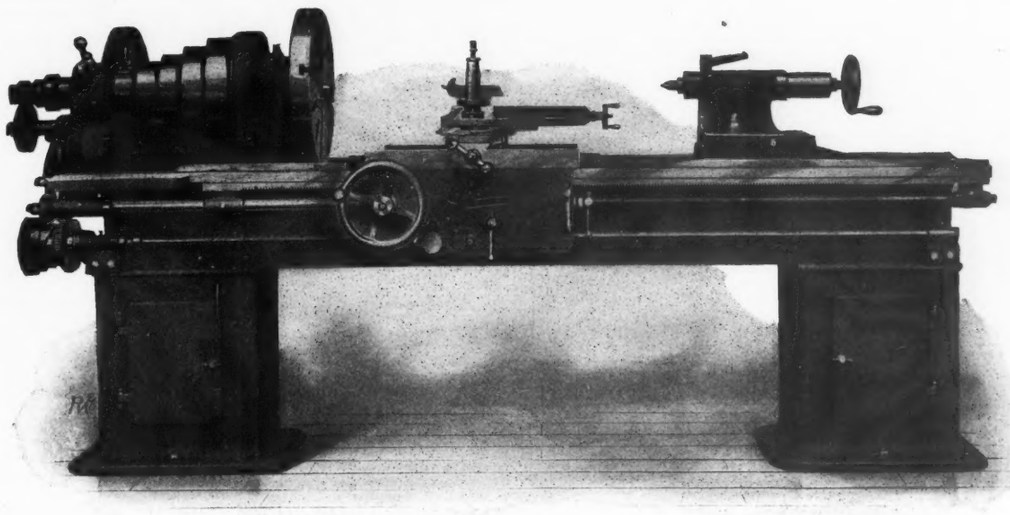
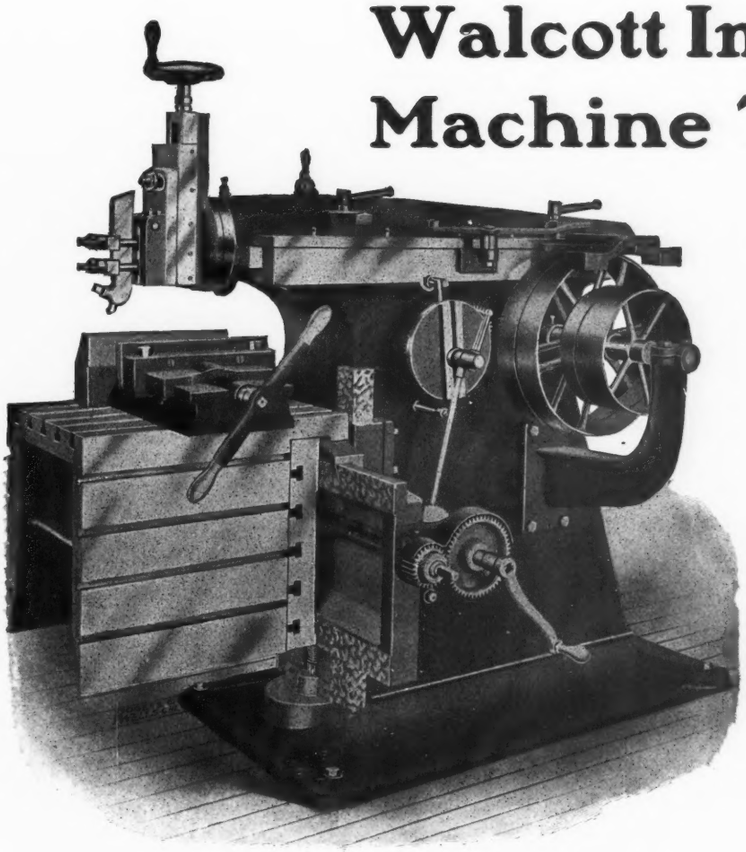


18 inch Engine Lathe.

Two Representative Examples

OF THE

Walcott Improved Machine Tools



34 inch Geared Shaper

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15 inch, 18 inch, 22 inch and 32 inch Swing.

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22 inch, 26 inch, 30 inch, 34 inch and 48 inch stroke.

Elliptical Gear Crank Shapers.

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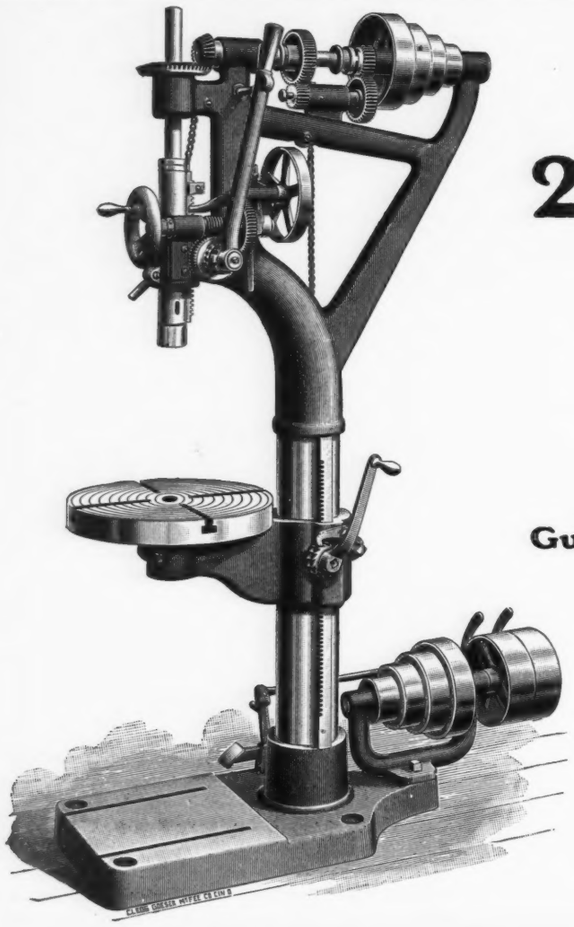

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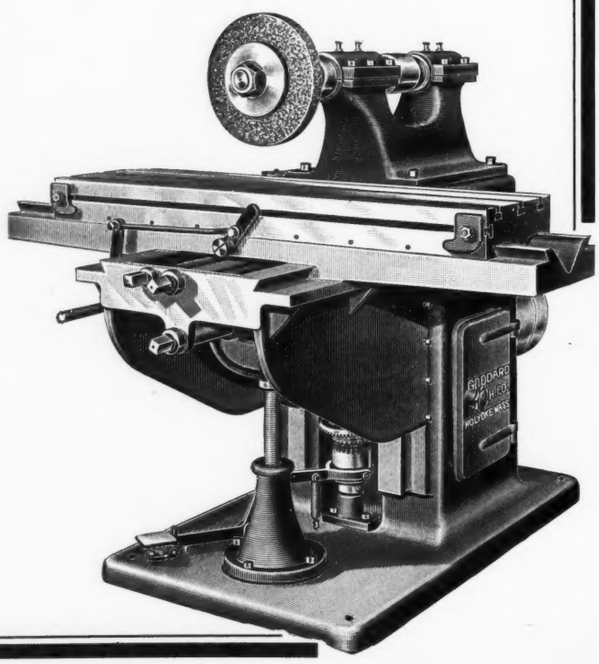
OUR grinding machines are modern tools and we place them on the market with the firm belief that they embody all the best features that experience can suggest with none of the defects common to this class of machine. Next to being accurate and rapid they are above all convenient.

We show a cut of our No. 6 Grinder, strong and sturdy; it will give good service for a lengthy period. This tool always had a good reputation, but we have redesigned, rebuilt it, for a better reputation.

We have issued a descriptive circular covering the entire machine, point by point—write for one.



Goddard Machine Co.

HOLYOKE, MASS.

Bargains in New Lathes

All the Lathes in list below are new and complete with regular equipment. We have them in stock and can ship promptly. We are offering them at greatly reduced prices which we will be pleased to quote if you will kindly write us.

13″ x 6′ Blaisdell Lathe. C. R.
18″ x 8′ Blaisdell Lathe. C. R.
20″ x 10′ Blaisdell Lathe. C. R.
20″ x 10′ Blaisdell Lathe. C.R.&T.A.
14″ x 6′ Johnson Lathe. C. R.
15″ x 6′ Flather Lathe. C. R.
17″ x 8′ Flather Lathe. C. R.
20″ x 12′ Flather Lathe. C. R.
18″ x 10′ Draper Lathe. C. R.
20″ x 12′ Draper Lathe. C. R.
24″ x 16′ Draper Triple Geared Lathe. C. R. & T. A.
28″ x 16′ Draper Triple Geared Lathe. C. R. & T. A.
16″ x 6′ Porter Lathe. C. R.
38″ x 20′ New Haven Lathe. C. R.
38″ x 18′ Pittsburg Machine Tool Co's Triple Geared Lathe.
16″ Putnam Shaper.

Other New Machines which we have in stock and can ship promptly

36″ x 16″ Schumacher & Boye Engine Lathe.
No. 2, 3 and 4 Brown and Sharpe Universal Milling Machines.
26″ x 48″ x 16′ McCabe New Style Double Spindle Lathe, with Geared Face Plates.
No. 3 "Cleveland" Bar Shear, to cut 2″ Bars.
"Lewis" Bolt Header, with Shear Brackets.
"Betts" 14′ Extra Heavy Boring and Turning Mill.
"Betts" 6′ Boring and Turning Mill.
"Betts" No. 1 Horizontal Boring and Drilling Machine, 6′ table.
Acme 2½″ Single Class A Bolt Cutter.
Warner and Swasey Hollow Hexagon Turret Lathe.
3″ x 4″ and 6″ x 7″ Air Compressors.
20, 21, 24, 28, 30, 34 and 40″ Upright Drill Presses.
3, 4, 5 and 7′ Arm Prentice Radial Drills.
16, 20 and 24″ Eberhardt Extension Base Shapers.
24 x 24 x 6 Flather Planer, 1 Head.
27 x 27 x 8 Powell Planer, 1 Head.
30 x 30 x 10 Flather Planer, 1 Head.
30 x 30 x 8 Flather Planer, 1 Head.
36 x 36 x 12 Flather Planer, 3 Heads.
42 x 42 x 10 Power Planer, 3 Heads.
No. 0 and No. 50 Fay & Egan Band Saw.

Our List of Second-Hand Machinery will interest you—it's full of Bargains. Write for it.

Baird Machinery Company, 123-125 Water St. Pittsburg, Pa.

All Kinds of Machinists' Tools and Supplies

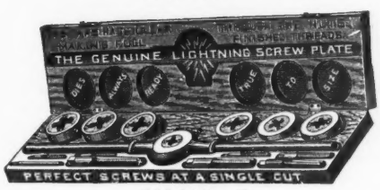
Celebrated Screw Plates

Our **"Green River"** and **"Lightning" Screw Plates** do their work at a single cut. Adopted everywhere; doing work better and more easily than with old methods.

"Full Mounted Lightning"

THE TAPS PASS CLEAN THROUGH THE NUTS
MAKING FULL FINISHED THREADS
THE GREEN RIVER SCREW PLATE
DIES ALWAYS READY TRUE TO SIZE
PERFECT SCREWS AT A SINGLE CUT

"Green River"



"Lightning"

Send for illustrated catalogue of Screw and Bolt Cutting Machinery and Tools; Taps, Dies, Reamers and other tools for machinists and blacksmiths.

WILEY & RUSSELL MFG. CO.
GREENFIELD, MASS., U. S. A.

A Jack of All Trades

is not the kind of man that the world wants today. What the world does want is men who can do one thing well.

The International Correspondence Schools, of Scranton, Pa., are making men successful because they train them to be specialists and qualify them for the high positions in the leading modern trades and professions.

We can help you qualify, in your spare time, for promotion, or a more profitable occupation, or to commence work at a better salary than if you started without training. The accounts of the rise of some of our students read like romance. Many have risen from the lowest to the highest positions in their craft or calling. What we have done for others we can do for you. Decide today to better your condition—then let us help you.

Mark **X** before the position that interests you, fill in the coupon, and send it to us. We will send full particulars and our book entitled "1001 Stories of Success," which gives the names, addresses, and advancement of over a thousand of our students in all parts of the world.

Send Us the Coupon Today

International Correspondence Schools
BOX 980, SCRANTON, PA.

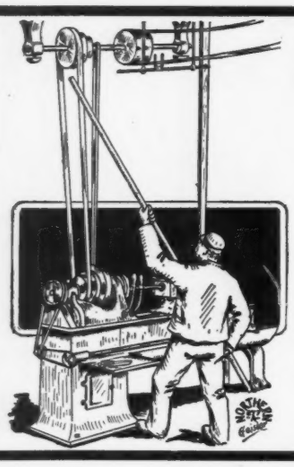
Please send me, free, a copy of "1001 Stories of Success," and explain how I can qualify for the position before which I have marked **X**.

__ Civil Engineer	__ Machine Designer	__ Ad Writer
__ Bridge Engineer	__ Mechanical Drafts.	__ Window Dresser
__ Electrical Engineer	__ Marine Engineer	__ Chemistry
__ Mechanical Engineer	__ Hydraulic Engineer	__ Sheet-Metal Drafts.
__ Stationary Engineer	__ Municipal Engineer	__ Ornamental Designer
__ Gas Engineer	__ R. R. Construc. Eng.	__ Textile Designer
__ Refrigera'n Engineer	__ Surveyor	__ Bookkeeper
__ Traction Engineer	__ Mining Engineer	__ Stenographer
__ Elec.-Lighting Supt.	__ Sanitary Engineer	__ Teacher
__ Elec.-Railway Supt.	__ Architect	__ French) With
__ Electrician	__ Architect. Draftsman	__ German) Edison
__ Telephone Engineer	__ Show-Card Writer	__ Spanish) Phonograph

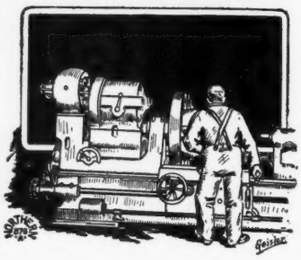
Name _____

St. and No. _____

City _____ *State* _____



How Do You Change Your Speeds?



At the end of a ten foot pole, or at your finger tips? The latter method is certainly preferable. Why?

Because it saves AN IMMENSE AMOUNT OF TIME.

Because YOU DON'T HAVE TO STOP YOUR MACHINE TO CHANGE THE SPEEDS.

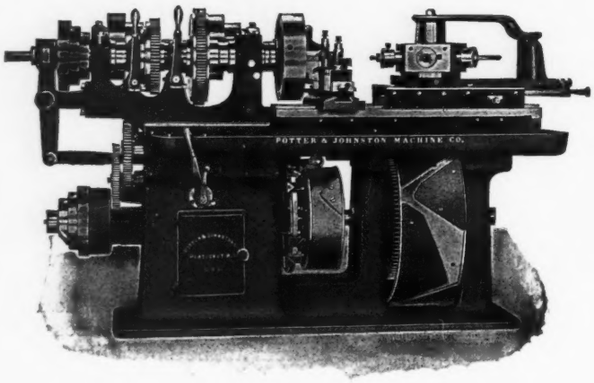
The numerous instances in which **Northern Variable Speed Motors** have paid for themselves in the saving of time over belt driven machines is proof enough of their economy. *Bulletin No. 2035.*

Northern Electrical Mfg. Co., Madison, Wis., U. S. A.

Engineers - Manufacturers

See Northern Exhibit at St. Louis, Section 14, Palace of Electricity 218

Automatic Production



on

Potter & Johnston Automatic Chucking and Turning Machines

Means Increased Output At Reduced Cost.

Automatically machines castings from iron, bronze or steel, also forgings, up to 14 inches diameter and 7 inches long.

One attendant operates a group of machines.

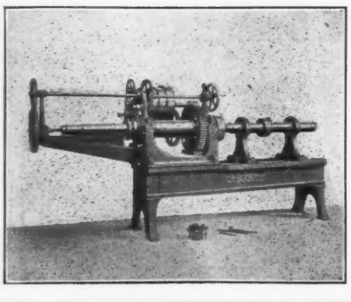
Send sketches or samples of your duplicate parts for estimate.

Potter & Johnston Machine Company, Pawtucket, R. I., U.S.A.

New York Office, 126 Liberty St., Walter H. Foster, Manager.

BRANCHES: Chicago, Cleveland, Pittsburg, Philadelphia, Boston FOREIGN AGENTS: Chas. Churchill & Co., Ltd., London, Birmingham, Manchester and Newcastle-on-Tyne, England, an 1 Glasgow, Scotland. Schuchardt & Schutte, Berlin, Cologne, Vienna, Brussels, Stockholm, St. Petersburg, Milano. H. W. Petrie, Toronto and Montreal, Canada.

William Sellers & Co. Incorp. Philadelphia, Pa.

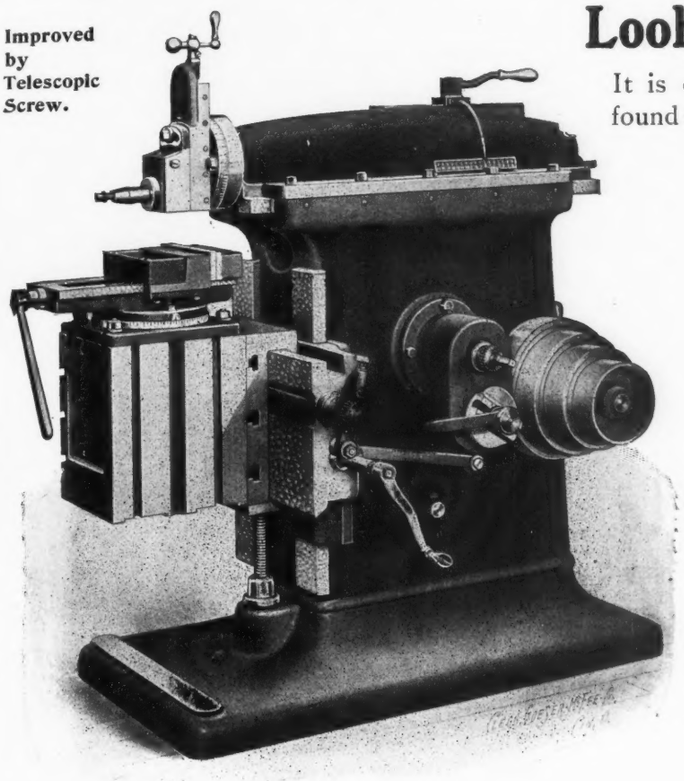


JIB CRANES
TRAVELING CRANES
TOOL GRINDERS
DRILL GRINDERS

Modern Machine Tools

IMPROVED INJECTORS FOR BOILERS
SHAFTS, PULLEYS, COUPLINGS, HANGERS, ETC., ETC.

Improved by Telescopic Screw.



16 Inch Stroke Single or Back Geared.

Look at this Ram!

It is odd, but it is correct design, and is found only on our shapers. The maximum section of metal comes into service at the point where leverage is greatest. Bearing in column is 30¼" x 10". Position and length of stroke can be changed while tool is in motion or at rest. Is connected to Rocker Arm by a link, properly set, giving a straight pull and an even cutting speed, with a very quick return, and no lost motion.

The rest of the tool is fit backing for the ram. We have the latest and best at a very reasonable price. Ask us!

Queen City Machine Tool Co.,
Cincinnati, Ohio.

FOREIGN AGENTS: Selig, Sonnenthal & Co., London. J. Lambercier & Cie, Geneva, Switzerland. John Wall, Stockholm, Sweden. Roku-Roku Shoten Tokyo, Japan.

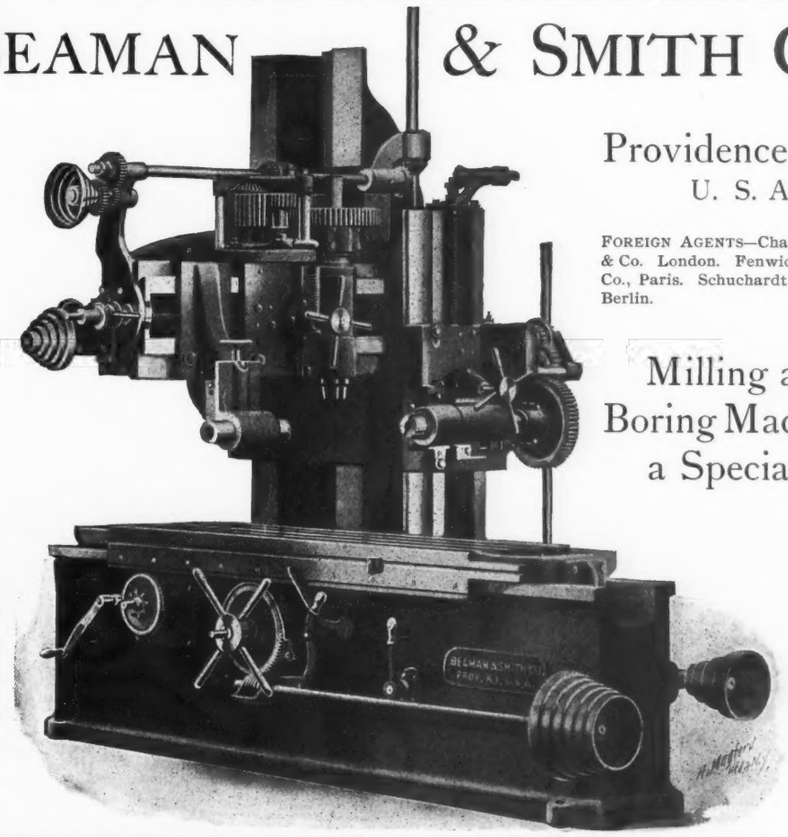
THE BEAMAN & SMITH CO.

Providence, R. I.,
U. S. A.

FOREIGN AGENTS—Chas. Churchill & Co. London. Fenwick Freres & Co., Paris. Schuchardt & Schutte, Berlin.

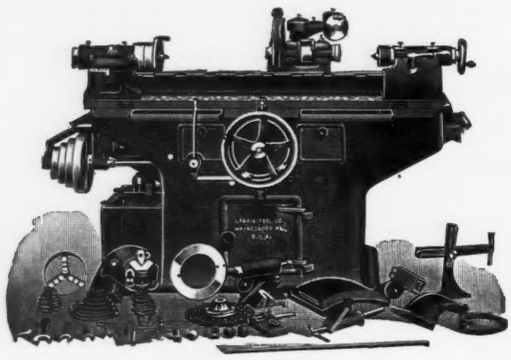
No. 1 Combined Vertical and Horizontal Spindle Milling Machine

CODE WORD, "CHARISTON"



Milling and Boring Machines a Specialty.

An exceedingly convenient and efficient tool. Spindles driven in unison or independently. Table work surface 18 in. wide, 6 ft. long.



Landis Grinders.

It is not profitable to continue the use of a machine that is worked to it's limit of capacity and fails to turn out the maximum amount required. Better to buy a machine of up-to-date design built with a view to meet current needs capable of maximum production, for it will more than make up it's cost in the extra amount and better grade of work done.

To finish work on the lathe is not profitable nor is the work finished as accurately or true as specifications now demand. On the other hand a good grinding machine will not only turn out perfectly true, accurate work, but will do it in about half the time taken on a lathe and at less cost.

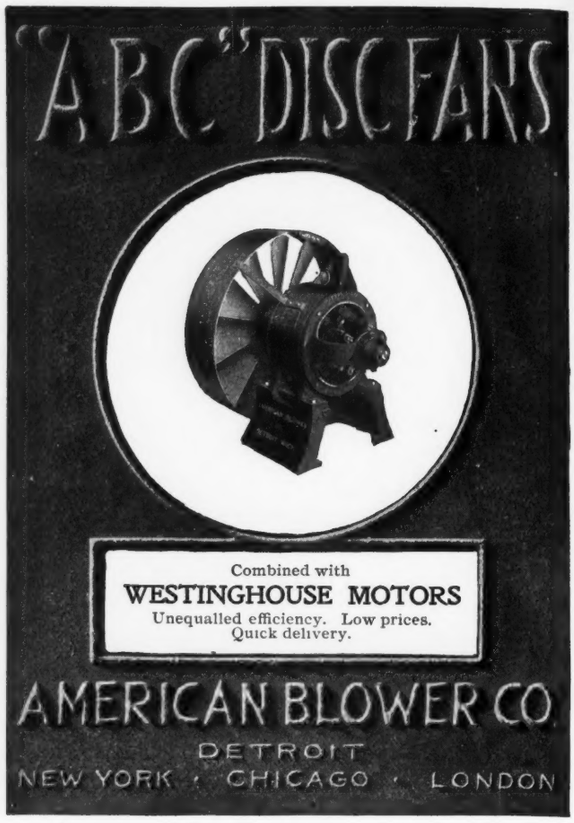
We would like to send you a set of illustrated folders describing in detail LANDIS GRINDERS. You will not only find them profitable reading, but will be surprised at the results set forth therein as obtained on

LANDIS GRINDERS.

Landis Tool Co.

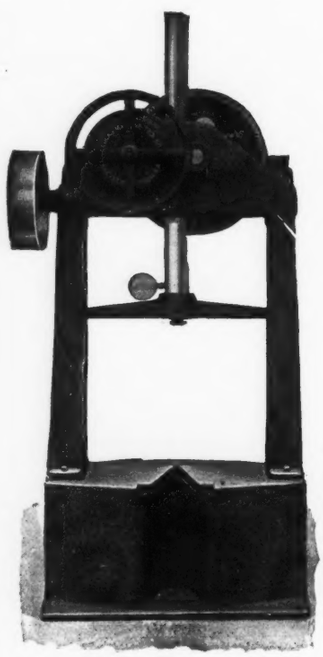
Waynesboro, Pa.

AGENTS: Walter H. Foster, Manager, New York and Boston. C. W. Burton, Griffiths & Co., London. Schuchardt & Shutte, Berlin, Cologne, Vienna, Brussels, Liege, Paris, Milano, Bilbao, Stockholm and St. Petersburg.



AUGUST SUGGESTS VACATION AND REST.

Why work so hard, anyhow?



Use the Lucas Power Forcing Press and let the Belt do the Work!

It is not hard work to adjust the spindle of our "PRECISION" Boring, Drilling and Milling Machine, either. (You don't have to adjust the table.)

Lucas Machine Tool Company

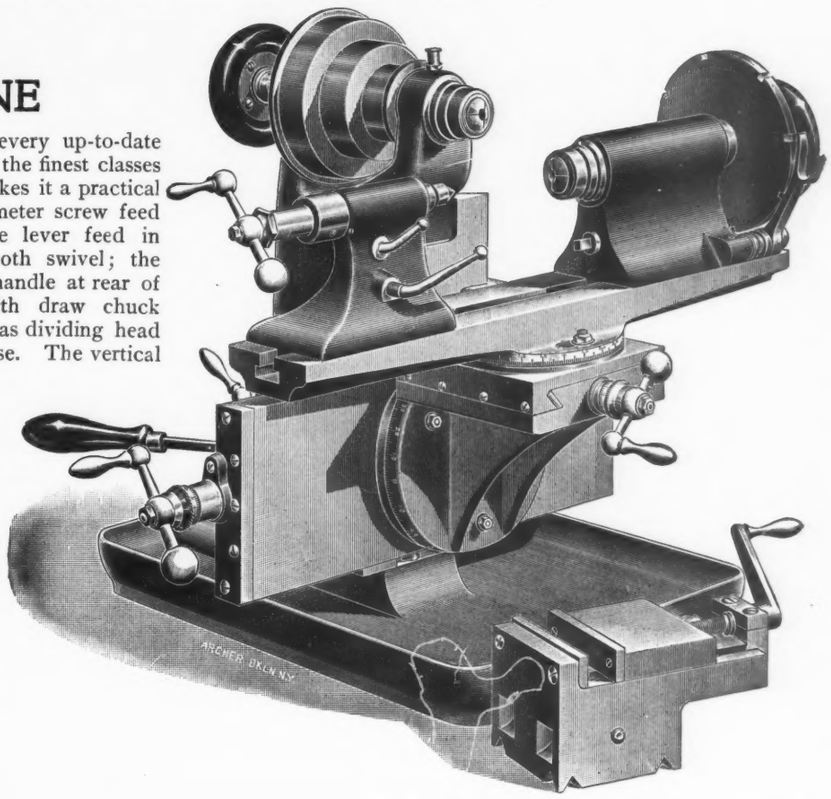
Glenville Station, **Cleveland, Ohio, U. S. A.**

SLOAN & CHACE MFG., CO., Limited,

291 WASHINGTON STREET, NEWARK, N. J.

MAKE A BENCH MILLING MACHINE

That should have a place in every up-to-date machine shop. It is adapted for the finest classes of work and has a range that makes it a practical economy. Provided with micrometer screw feed in three directions and sensitive lever feed in addition; the knee and table both swivel; the elevating screw is operated by handle at rear of machine; the spindle fitted with draw chuck similar to a bench lathe; table has dividing head with draw chuck, centers and vise. The vertical travel of this machine is 4 inches; longitudinal, 8 inches; parallel to spindle, 2¼ inches. Write us for full description of this machine and our other specialties which includes



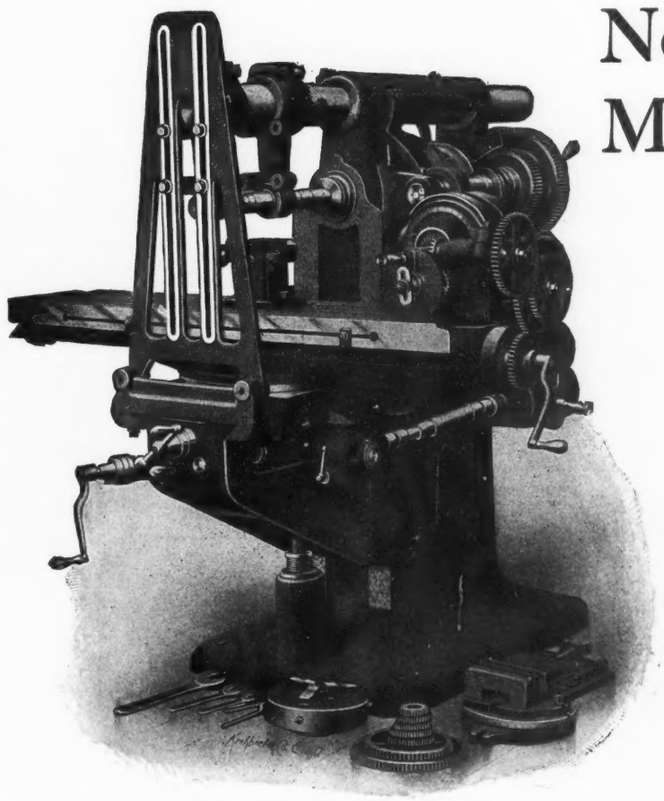
Bench Lathes and Attachments.

Bench Drill Presses

Bench Tapping Machines

Automatic Gear Cutters

Automatic Pinion Cutters



No. 3 Universal Milling Machine

THIS machine has the spindle driving power. It is double back geared, giving it double the power of a single back geared machine. It has a feed range from .006 to .255 per revolution of spindle. The feed is driven entirely by spur gears. All changes of feed can be made without stopping the machine. One handle does the business. Spindle power is sufficient to pull a cut when the limit of feed is taken. It will do this with a surface mill. If you want to test a miller the surface mill is the mill to test the machine. Any machine made will pull a heavy cut when using a face mill. Most work cannot be milled this way. We would like to convince you of these facts and the superiority of our machine. If interested in powerful, work-producing, time-saving, money-making milling machine practice, write us for booklet.

The R. K. Le Blond Machine Tool Co.

CINCINNATI, OHIO, U. S. A.

J. Lambercier & Co., Sole Agents for Switzerland.

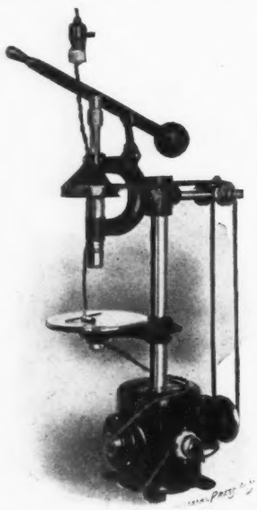
One of the Keller Money Makers

KELLER PNEUMATIC RIVETING HAMMER
MADE IN SIX SIZES.

They do more work, in less time, and with less cost for repairs, than any other pneumatic hammers made.

Write for Catalogue and Prices of KELLER TOOLS.

PHILADELPHIA PNEUMATIC TOOL CO.
21st and Allegheny Avenue, Philadelphia.



Portable 10-inch Electric Sensitive Bench Drill

For 110 or 220 volt direct current

FIVE SPEED CHANGES
500, 750, 1,000, 1,350, 2,000 R. P. M.

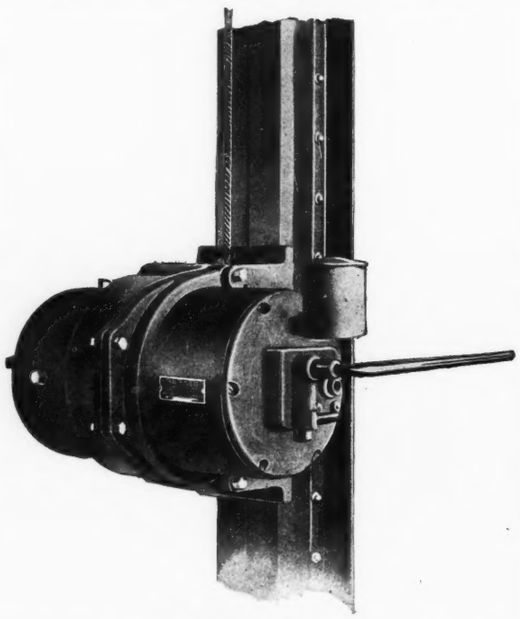
Can be plugged direct into lamp socket. The drill capacity of this machine is ¼-inch, the weight 100 pounds.

YOU NEED IT!

Bartz, Wygant & Brown
Hornellsville, N. Y.

Manufacturers of...
MOTORS AND DYNAMOS

JIB CRANE AND DERRICK HOIST

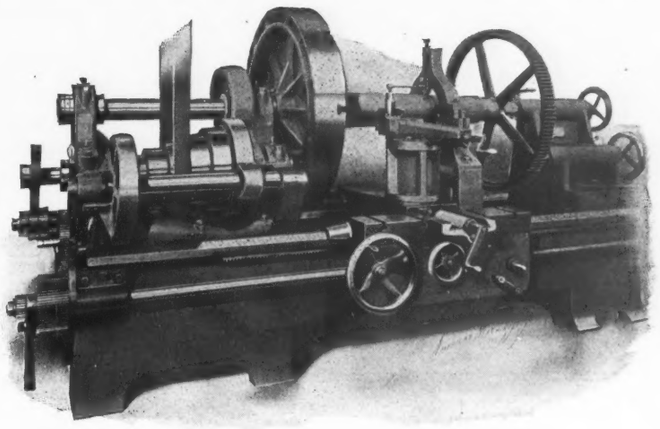


Pneumatic HOISTS Electric
For Every Kind of Service

Hung by a single hook; combined with trolleys; or with base for Jib Cranes or Derricks.

The **General Pneumatic Tool Co.**
Montour Falls, N. Y.

"What Fools We Mortals Be"



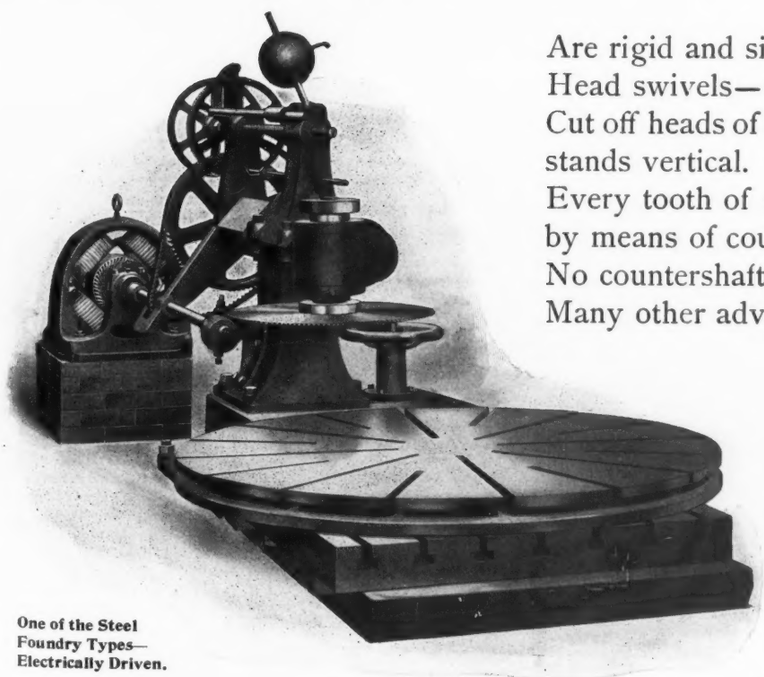
McCabe's "New Style" 26-48-in. Double Spindle Lathe

Yes, and you're going to make even a worse mistake than some of the Russian Commanders, if you go ahead and buy a regular 48-inch Lathe without investigating McCABE'S PATENTED "DOUBLE-SPINDLE" MACHINE. There's a reason, of course, or rather several reasons, but we'll skip the reasons and get down to facts. McCABE'S "DOUBLE" is better by all odds—never "out of commission" as the saying goes, for it has an "extra" 26-inch Swing for any smaller work. Sounds interesting, doesn't it? But that's not all; no, not by any means, when we tell you it costs half as much as a regular 48-in. Lathe, then you're beginning to "catch on". Still the explanation of how we do it is of no interest to you; what you want to know is that 500 prominent, up-to-date shops have already "caught on" and have these "Double" Lathes in operation. Let's give you a terse summary in the shape of a catalogue.

J. J. McCabe, 14 Dey St., New York City.

Foreign Agents—Chas. Churchill & Co., London, Birmingham, Manchester and Glasgow.

WAGNER COLD SAW CUTTING-OFF MACHINES



One of the Steel Foundry Types—Electrically Driven.

Are rigid and simple in construction.
Head swivels—cuts any angle.
Cut off heads of steel castings when head stands vertical.
Every tooth of saw brought into action by means of counter-balanced feed.
No countershaft required.
Many other advantages.

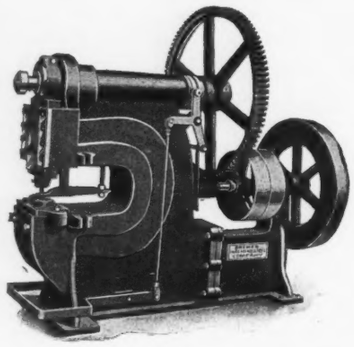
MANUFACTURED BY

Diamond Drill & Machine Co.

First Street,

BIRDSBORO, PA.

Pittsburg Office, Farmers' Bank Building.



Punches and Shears

SECOND TO NONE.

Single.
Double.
Horizontal.
Built to last.
Various sizes.
Various depths of throats.
A most effective tool.
Adapted to wide range of work.
Standard in design and workmanship.
A combination of strength, rapidity and accuracy.

Write for Bulletin No. 530.

The C. E. Sutton Co., Toledo, Ohio, U. S. A.

The World's Fair Official Machine Shop

AT ST. LOUIS

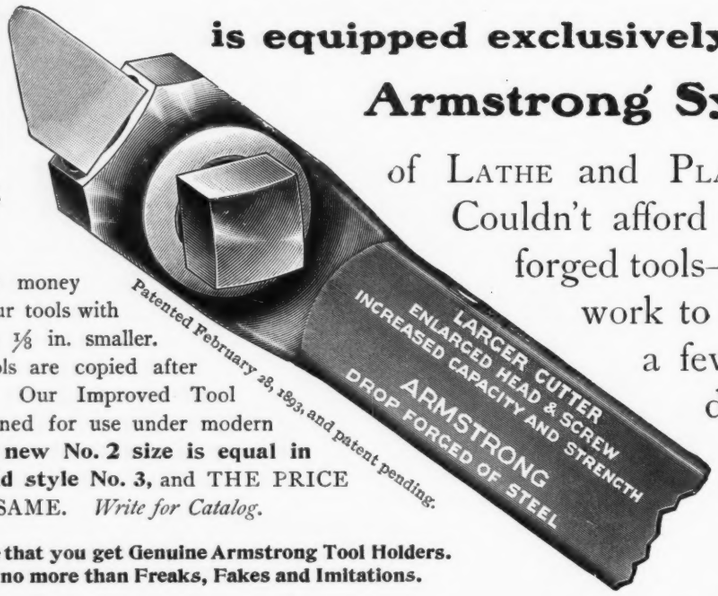
is equipped exclusively with the

Armstrong System

of LATHE and PLANER TOOLS. Couldn't afford to fool with forged tools—lots of rush work to do and only a few months to do it.

ARMSTRONG PATENTS.

February 28, 1893.
March 12, 1895.
April 18, 1898.
November 8, 1898.
November 14, 1899.
September 29, 1900.
January 29, 1901.
May 28, 1901.
May 27, 1902.
August 19, 1902.
April 14, 1903.
December 1, 1903.



DON'T BE FOOLED

into putting your money into imitations of our tools with cutters 1-16 in. to ⅛ in. smaller. Such imitation tools are copied after our old designs. Our Improved Tool Holders are designed for use under modern conditions and **our new No. 2 size is equal in capacity to our old style No. 3,** and THE PRICE REMAINS THE SAME. *Write for Catalog.*

When you order see that you get Genuine Armstrong Tool Holders. They cost you no more than Freaks, Fakes and Imitations.

Complete Line on Exhibition, Block 12, Palace of Machinery.

Armstrong Bros. Tool Co., "THE TOOL HOLDER PEOPLE," **613 Austin Ave., Chicago, U.S.A.**

FOREIGN AGENTS—Chas. Churchill & Co., Ltd., London, Manchester, Birmingham, Glasgow. Schuchardt & Schutte, Berlin, Brussels, Vienna, St. Petersburg. G. Koeppen & Co., Moscow. C. S. Christensen, Christiania. Aikenhead Hardware, Ltd., Toronto, Canada. Williams & Wilson, Montreal, Canada. Palmer & Co., Wellington, New Zealand. Societe de Produits Metallurgique, Nancy, France.

IMITATIONS ARE UNSATISFACTORY---INFRINGEMENTS ARE UNLAWFUL.

A PAIR OF SUPERIOR GAS FORGES

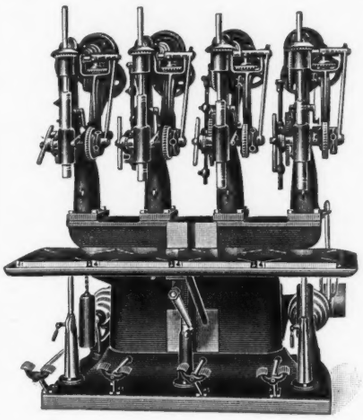
For heating high speed steel tools, such as Lathe and Planer Tools, Short Drills, Taps and Reamers.

This style forge is made in two sizes, No. 1 having capacity for heating 1½″ bars a length of four inches, and No. 2, for 2″ bars a length of six inches. We also make a Bench Forge of similar style, and shall be glad to send you our latest bulletin of Gas Blast Furnaces and Heating Machines.

American Gas Furnace Co., **23 John Street NEW YORK**

Chas. Churchill & Co., London, Birmingham, Manchester and Glasgow. H. Glaenzer & Perreaud, Paris. Schuchardt & Schutte, Berlin, Cologne, Vienna, St. Petersburg.

The Leader of All Gang Drills



FOR ITS SIZE IS OUR 20" MANUFACTURERS' DRILL

The most rapid working Multiple Spindle Drill on the market.
Furnished in from Two to Six Independent, Self-operating Spindles.
Particularly adapted for quick and accurate drilling or reaming on multiple pieces of work.
The spindles go down to work, do it and return automatically. No feed levers to bother with. The operator is kept busy taking the work to and from the jigs.
A great time and labor saver, hence a cost reducer for your shop.
Built also in 14" size.
Ask for Catalogue and information regarding our

New Automatic Revolving Chuck

B. F. BARNES COMPANY, - Rockford, Ill.

Block 12, Machinery Hall, World's Fair.

MECHANICAL TRADE VIM MARK LEATHERS

Something New About Pulley Covering.

Heretofore leather has been only partially successful as a pulley covering, because when the belt slips it burns the leather covering. You cannot burn VIM leather with an emery wheel, so no slipping belt will affect it. Again, it will give the greatest possible grip to the belt. It is sold with the guarantee that, unless these statements prove true, no pay will be asked. Send for further particulars.

MADE ONLY BY

E. F. HOUGHTON & CO.

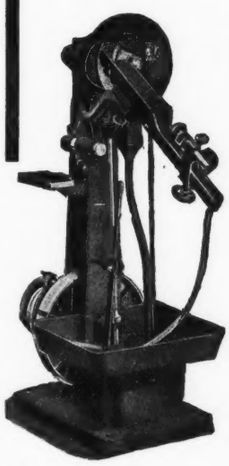
240-250 W. Somerset St., Philadelphia.

175-177 Lake St., Chicago, Ill.
98-110 Bates St., Detroit, Mich.

4

OF COURSE

you can grind drills by hand. So *can* we. We *can* also drill holes by hand but that isn't saying it pays or would be done as well. The



STY. E P.

New Yankee Drill Grinder

grinds drills *right.*

RESULT: The drills do *good* work, do it *quick,* and *much of it.*

It's presence in thousands of shops proves this.

What about yours?

If not equipped with one of these **"New Yankees"** may we have your address?

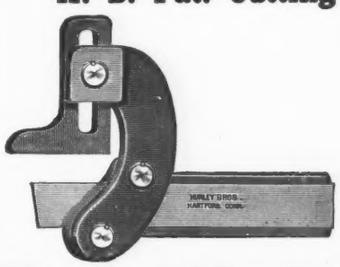
We've some interesting facts to present to you.

When in St. Louis, see our exhibit, Block 11, Aisle C, Machinery Building.

Wilmarth & Morman Co.,

155 Canal St., Grand Rapids, Mich.

H. B. Pat. Cutting-off Tool.

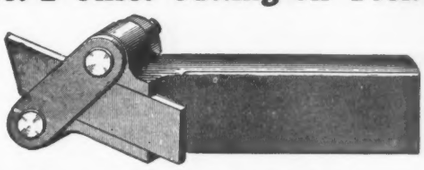


Something New and Good.

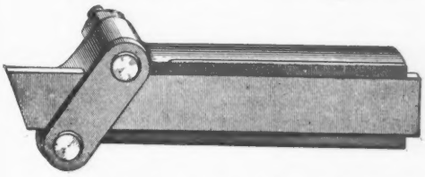
Brass or Steel foot rests. Uses regular Slate Blades. Shank same as Slate No. 2.

Slate No. 2 Offset Cutting-off Tool.

Shank $1\frac{1}{8}$x$\frac{1}{2}$"



Slate No. 2 Cutting-off Tool.



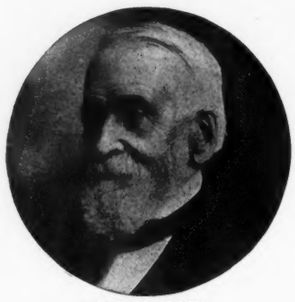
Shank $1\frac{1}{8}$x$\frac{1}{2}$". Blades $\frac{1}{16}$ to $\frac{1}{4}$" by 16ths. Special sizes by 1000ths made to order.

Also **Crescent Cutting-off Tools.** Straight shanks, no projections, for screw machine use. No. 2, $1\frac{1}{4}$x$\frac{1}{2}$". No. 3, $1\frac{7}{16}$x$\frac{5}{8}$" shank. No. 2 blades $\frac{7}{8}$" wide. No. 3, 1" wide, all thicknesses. For sale by supply dealers, or

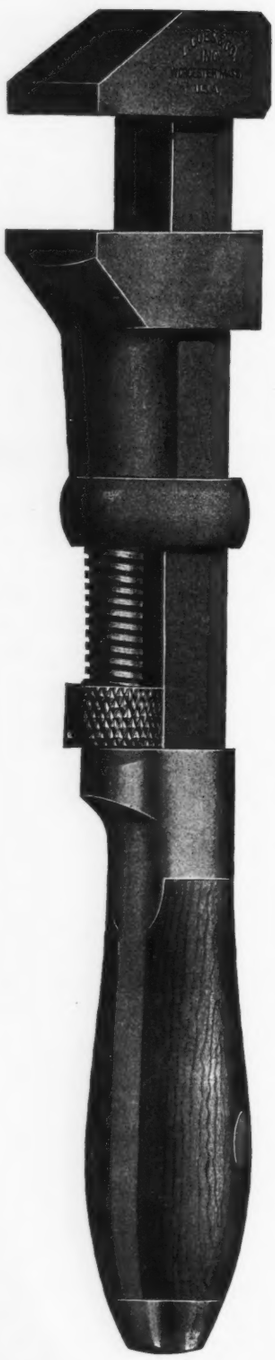
Dwight Slate Machine Company

HARTFORD, CONN.

There are Wrenches and Wrenches but Coes Genuine "Knife-Handle" Wrench Outwears Them All



LORING COES



The making of a wrench is a matter of pride and principle with Coes. Nothing but the best enters into the make-up of the tool—design, material, workmanship, finish all the finest, and the complete wrench stamped with the maker's name—a guarantee of excellence.

COES' GENUINE "KNIFE-HANDLE" WRENCH is a general service wrench made in seven sizes, 6, 8, 10, 12, 15, 18 and 21 inch, finished bright or black, and constructed to stand the hardest kind of usage. The prominent features are: hardened steel bar and jaw, steel castings in the handle, hardened steel screw, steel rivet and key, and handle of HARD wood secured at both ends.

Every Coes Wrench is warranted. Beware of imitations, there is only one genuine "Knife-Handle" Wrench—Coes. "Order by Name."

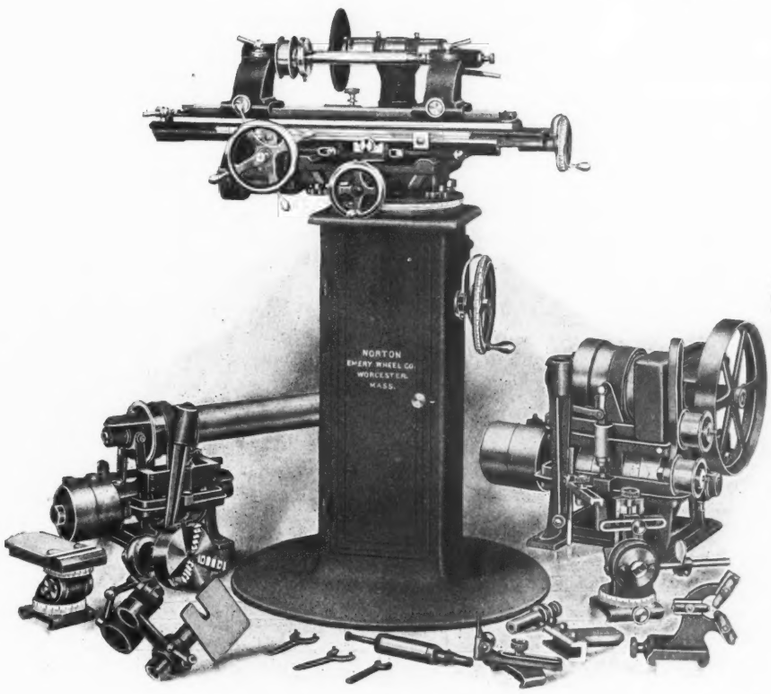
Coes Wrench Company

Worcester, Massachusetts

SALES AGENTS—J. C. McCarty & Co., 10 Warren Street, New York
and John H. Graham & Co., 113 Chambers Street, New York

"NORTON"

UNIVERSAL TOOL AND CUTTER



Number 1.

GRINDERS.

Takes 16″ between centres. Swing 8″, or 10″ if desired.

The following attachments are included with this machine: Automatic feed, 5-speed countershaft, 4-speed drum countershaft, 5″ chuck and spindle, No. 1 internal grinding attachment, universal vise, combination attachment, and an assortment of wheels together with collets on which to mount them.

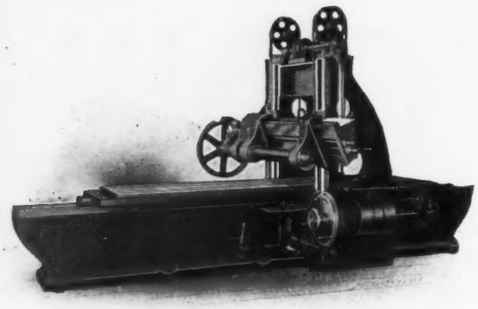
All attachments are interchangeable and can be furnished at any time as required.

Our No. 2 Machine, built on similar lines, swings 12″ and will take 36″ between centres.

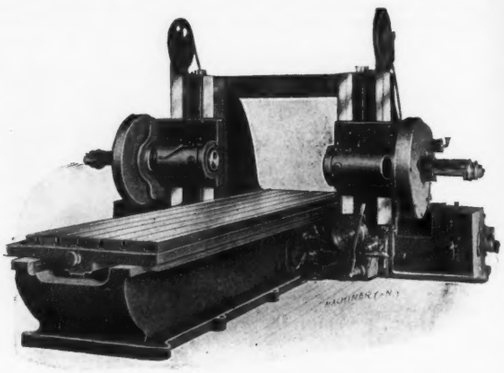
WRITE FOR COMPLETE ILLUSTRATED CATALOG.

Norton Emery Wheel Company

Chicago Store, 25 So. Canal St. **WORCESTER, MASS.**



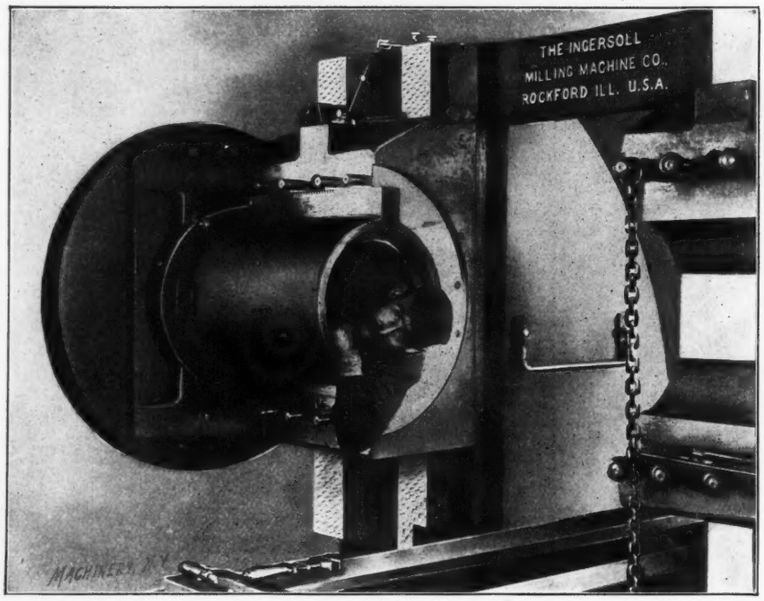
Standard Horizontal Type



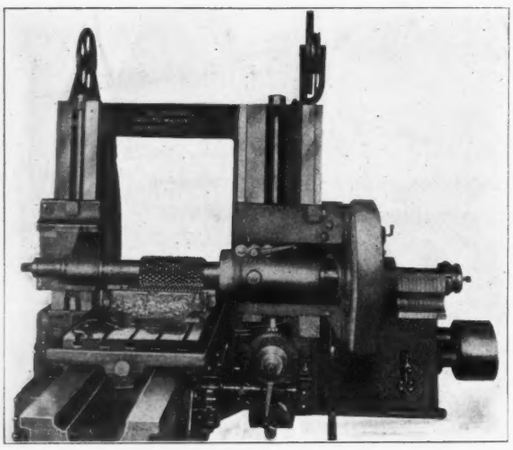
Duplex Horizontal Heavy Type

Heavy Milling Machines Exclusively

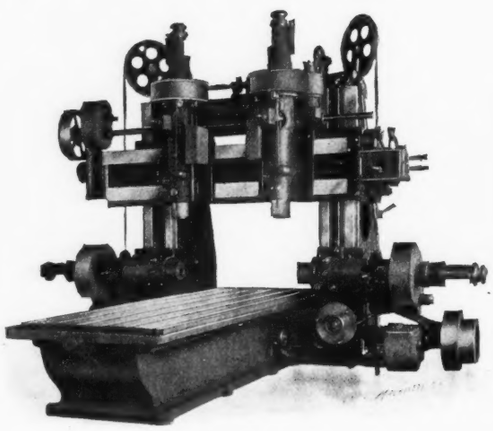
ALL TYPES



The Spindle Bearings on some of our heaviest machines are large enough for a man to crawl through



Heavy Type Horizontal Milling Steel Racks



Four Head Type

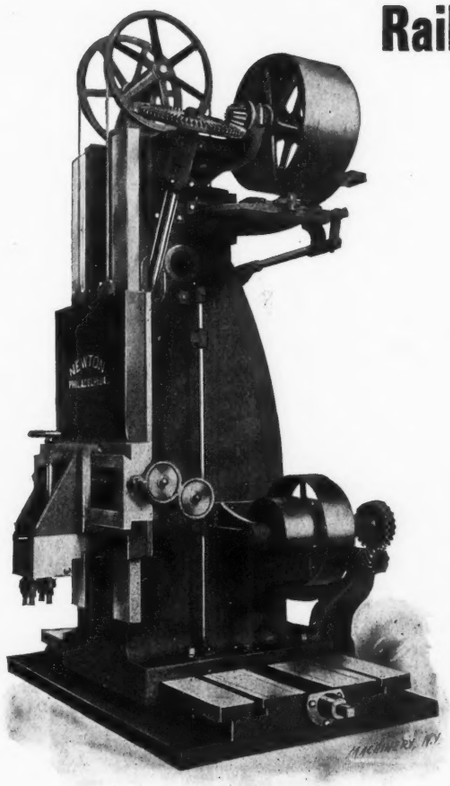
The Ingersoll Milling Machine Company, Rockford, Ill. U. S. A.

Eastern Branch, 126 Liberty Street, New York

NEWTON

Railway Machine Shop Equipment

COLD SAW CUTTING-OFF MACHINES,
LOCOMOTIVE ROD BORING MACHINES,
LOCOMOTIVE ROD MILLING MACHINES,
RAIL DRILLING MACHINES,
DRIVING BOX SHAPERS,
SLOTTING MACHINES.



48-INCH PORTABLE SLOTTING MACHINE

PORTABLE MACHINE TOOLS OF VARIOUS DESIGNS AND SIZES, INCLUDING:

HORIZONTAL BORING AND DRILLING MACHINES,

MULTIPLE RADIAL DRILLING MACHINES,

ROTARY PLANING MACHINES,

MILLING MACHINES,

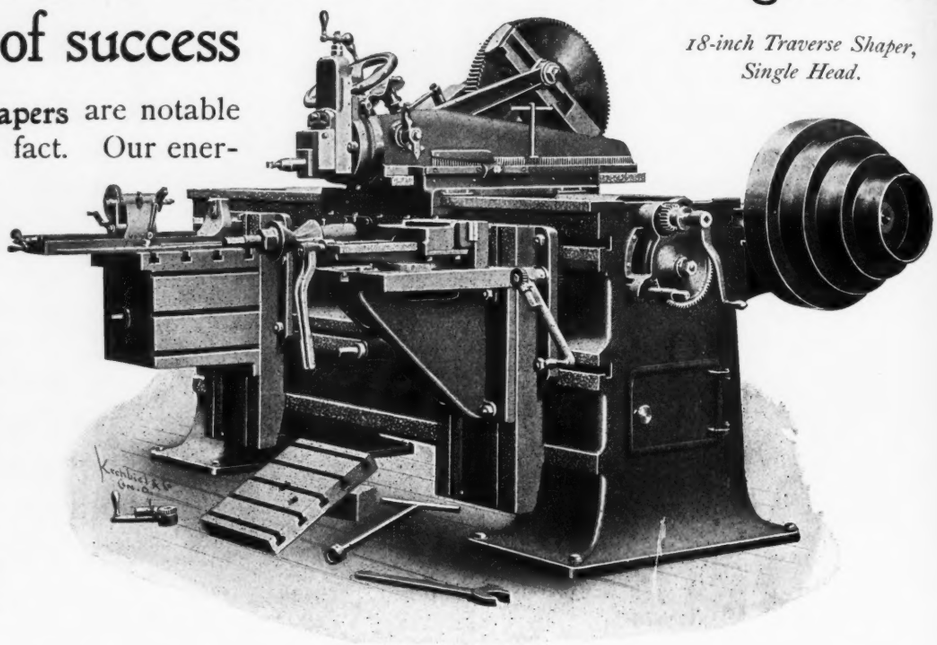
HEAVY SPECIAL MACHINE TOOLS.

18-INCH SLOTTING MACHINE

Newton Machine Tool Works, Inc.

Philadelphia, U. S. A.

Concentration of Effort is one of the greatest promoters of success



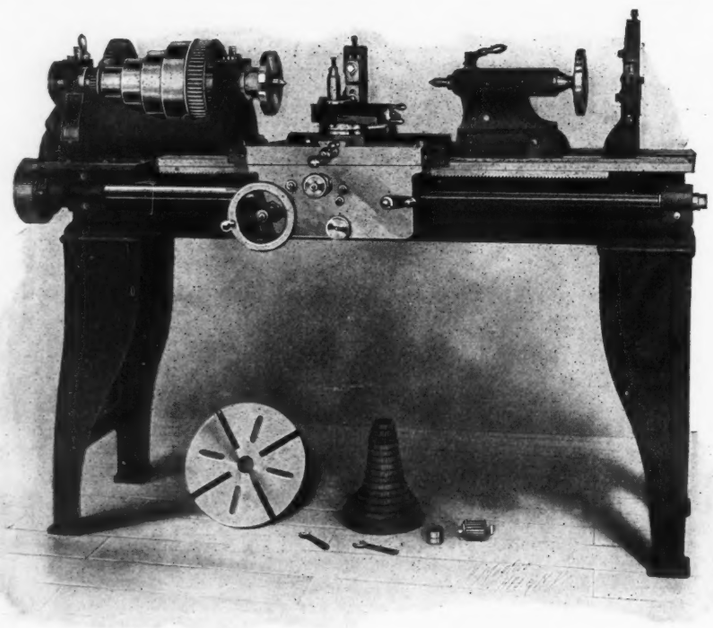
18-inch Traverse Shaper, Single Head.

and **Cincinnati Shapers** are notable illustrations of this fact. Our energies are entirely confined to building shaping machines and their attachments—high grade tools, in which every improvement and feature of advantage has been incorporated. The full line includes Crank Shapers, single and back geared, sizes from 16-inch to 24-inch. Triple geared Rack Shapers, 26 and 30 inch. Traverse Shapers, single or double head, sizes 18, 20, 24 and 36-inch.

BELT OR MOTOR DRIVE AS DESIRED. NEW CATALOGUE "C" MAILED ON REQUEST.

The Cincinnati Shaper Co., Cincinnati, Ohio, U. S. A.

14-inch Improved Engine Lathe



Particularly adapted for the requirements of modern machine shop practice. The Head Spindle is of high carbon steel, with bearings ground to size. Spindle Bearings are bronze, carefully scraped and fitted. Tail Stock, cutaway type, allowing the compound rest to be set in a plane parallel with the bed. Provision also made for setting the tail stock off the center for turning taper work. The Carriage is extra heavy at the waist, with long bearings on the V's and is securely gibbed to the bed. Apron is tongued and grooved into the carriage, has reverse feed, and all gears and studs of ample proportions. This lathe has all gear feeds. Three changes of feed obtainable by means of the friction gear on end of screw.

Write for further particulars and price. Lathe furnished complete with countershaft, plain or compound rest, center rest, follow rest, large and small face plates, wrenches and full set of change gears.

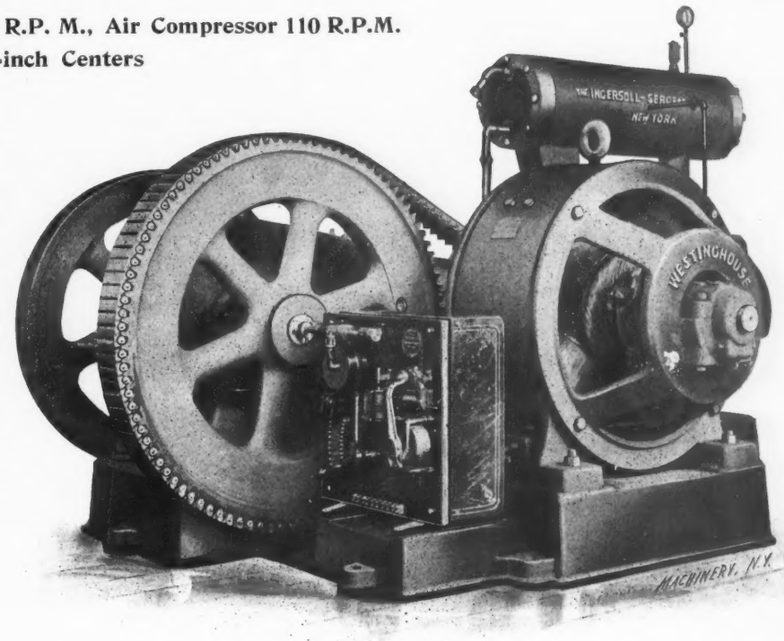
Fay & Scott, Dexter, Maine, U. S. A.

One of 40 Similar Morse Chain Drives used by the St. Louis Transit Company, St. Louis, Mo.

40 H.P, Motor, Speed 575 R.P. M., Air Compressor 110 R.P.M.
36-inch Centers

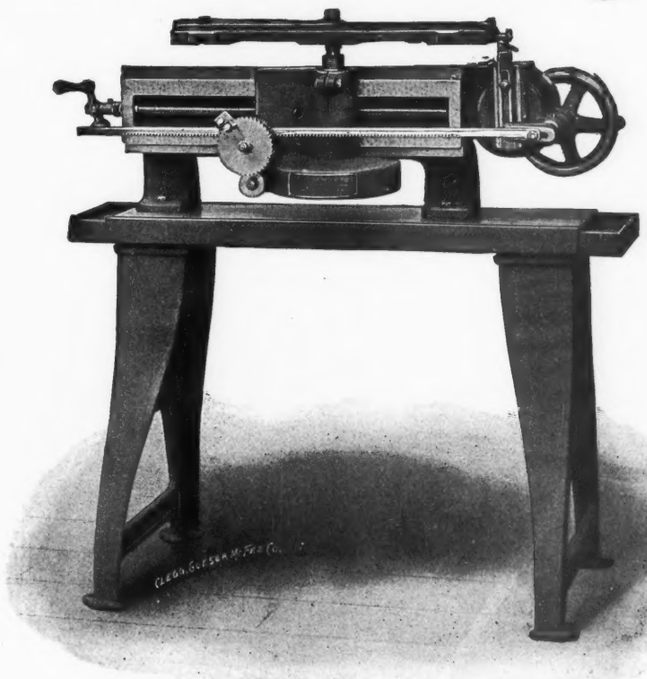
THE MORSE CHAIN is unequalled as a power transmitter and is used in many of the largest plants in the country. It is fitted for almost any service, will convey the maximum of power, is strong and durable, can be run on short centers, at highest speeds, is noiseless, not affected by heat, dust or moisture and requires very little lubrication.

Write for Chain Book; it will interest you.



Morse Chain Co., Trumansburg, New York

New Graduating Machine.



The machine shown herewith is designed for graduating all cylindrical parts. It will take work from the vertical to the horizontal, and the graduating head swings through an angle of 90 degrees. This machine will produce ten times as much work as an automatic gear cutter or milling machine, besides regulating the lengths of lines, insuring accuracy and no spoiled work.

For further information apply to

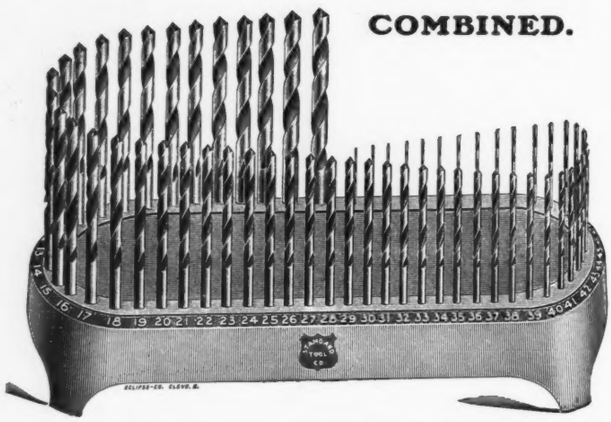
The R. K. LeBlond Machine Tool Co., 4605 to 4621 Eastern Ave., CINCINNATI, O., U.S.A.
J. Lambercier & Co., Geneva, Sole Agents for Switzerland.

TWIST DRILLS HIGHEST QUALITY

THE STANDARD

Metal Drill Holder and Gauge

COMBINED.



The Neatest and Most Convenient Drill Holder made.

Superior to the old style wooden block. Does not become worn in service. Serves as a drill gauge.

Manufactured Exclusively by

The Standard Tool Co., Cleveland, Ohio.

C. W. Burton, Griffiths & Co., London. Burton Fils, Paris. Carlos Dal Re, Madrid.
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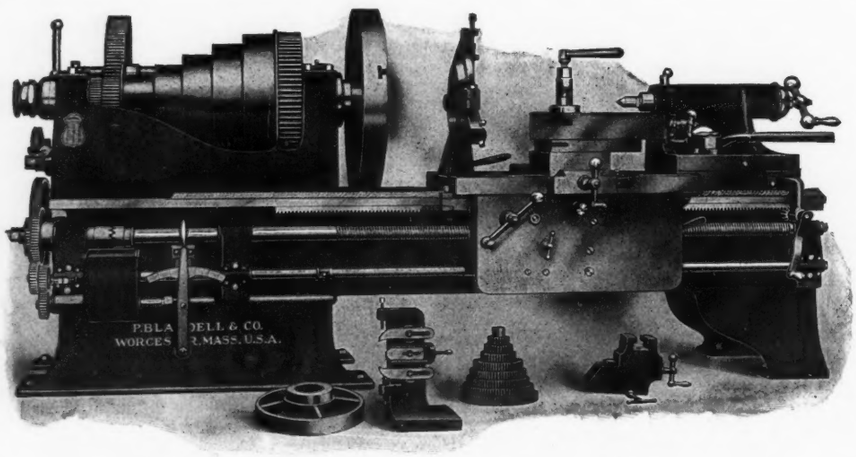
TWIST DRILLS HIGHEST QUALITY

Blaisdell's New Model Lathe



This new lathe has 31 inch swing, is equipped with Rapid Change Gear device, giving widest possible range of feeds, has double support in apron for steel rack gear—steel rack and gears wherever necessary. A well built, convenient tool and a notable addition to the time tried and reliable line of Blaisdell Machine Tools.

Lathes, 13″ to 31″ swing. Upright Drills, 20″ to 50″ swing. Speed Lathes, Crank Planers, etc.

P. Blaisdell & Co., 26 Jackson St., Worcester, Mass., U.S.A.

FOREIGN AGENTS—C. W. Burton, Griffiths & Co., London, Eng. Henry W. Peabody & Co., France and Australia. V. Lowener, Copenhagen, Denmark. Wilh. Sonesson & Co., Malmo, Sweden. DeFries & Co., Dusseldorf, Germany. Spliethoff, Beeuwkes & Co., Rotterdam, Holland.

The Taps:—

LITTLE GIANT

A trial convinces.
All styles and sizes.

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Fine Screw Cutting Tools.

The Makers:—

WELLS BROS. CO.

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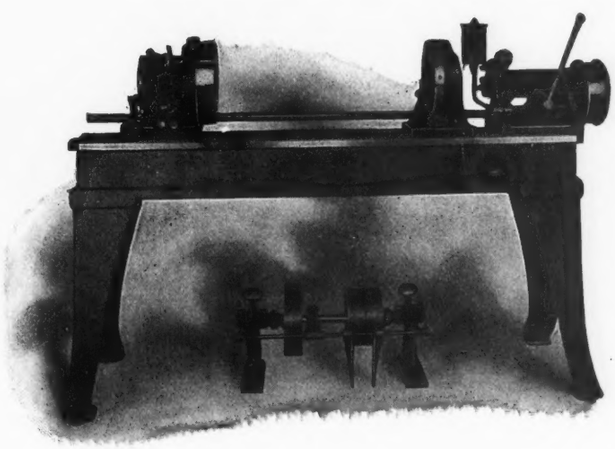
THE WHITON

Revolving Centering Machine

For Accurately Centering Finished Shafts.



The cut shows new REVOLVING CENTERING machine—a larger size of the well known machine of this type. It is heavier throughout and has capacity to center shafts up to 5 inches in diameter.

Constructed same as the smaller machine and embodies all the special features.

Circular and prices sent upon application.

The D. E. Whiton Machine Company,

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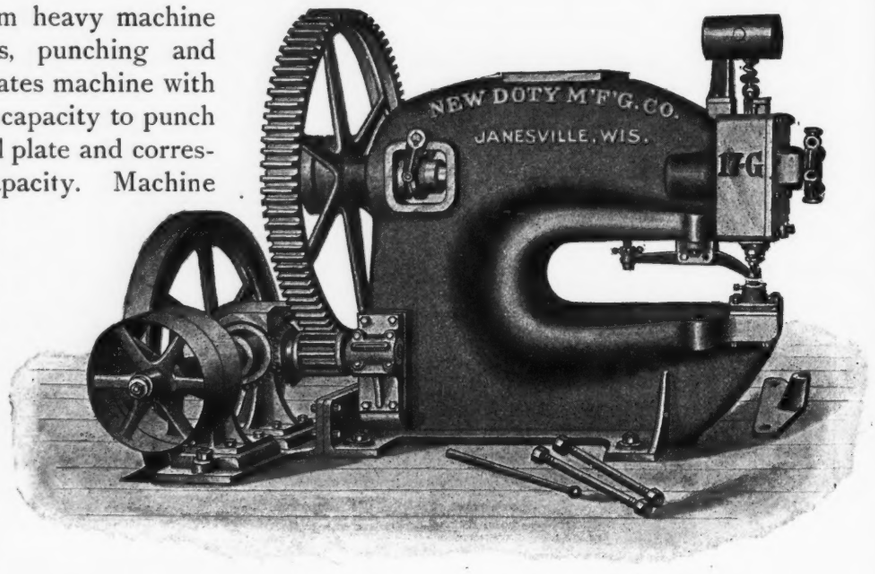
PUNCHES, SHEARS AND ROLLS

ALL SIZES FOR ALL CLASSES OF WORK. HAND OR POWER.

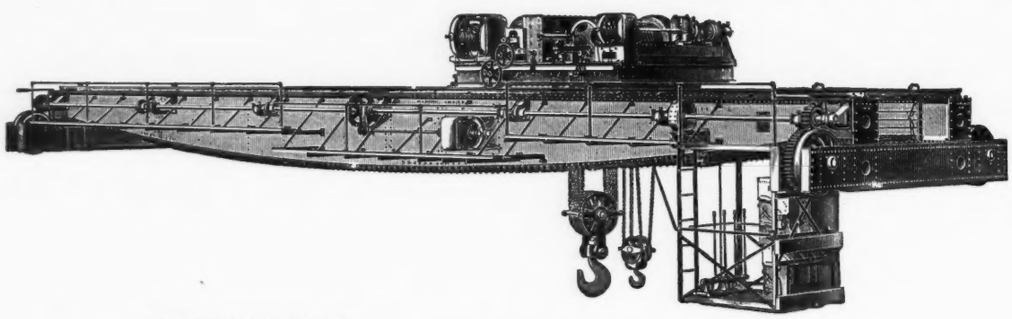
No. 17 G is a medium heavy machine for general purposes, punching and shearing. Cut illustrates machine with 30″ throat, having a capacity to punch a 1 ½″ hole in 1″ steel plate and corresponding shearing capacity. Machine as shown is equipped with right angle drive, which allows machine to be set at right angles to line shaft, without twisting belt. This type of machine is made in all sizes, with belt, motor or engine drive. Send for catalog D.



NEW DOTY MANUFACTURING COMPANY

Janesville, Wisconsin, U. S. A.

The Shaw Electric Traveling Crane



MANUFACTURED BY

The Shaw Electric Crane Company, Muskegon, Mich.

It is used in the MACHINE SHOP, the POWER HOUSE, the FOUNDRY, the STEAM PLANT.

It has few parts and is therefore simple and accessible.

It is durable, absolutely reliable and efficient.

The workmanship is top grade and the operating parts interchangeable.

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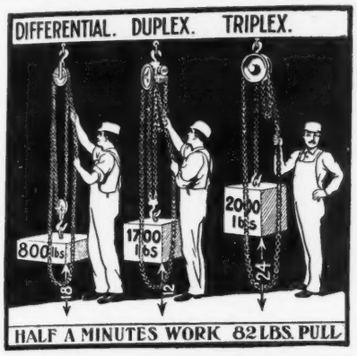


Half a Minute's Work

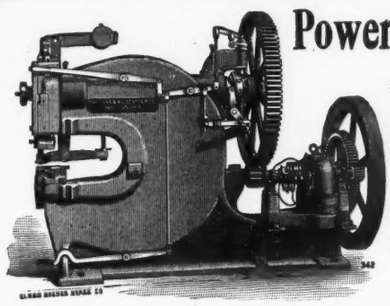
will handle heavy weights with ease if Yale & Towne Chain Blocks are available. One man with the Differential Block can lift a thousand pounds with ease, and he can lift many thousand pounds as easily with the Duplex and Triplex Blocks, which are made in sizes up to twenty tons.

The picture shows the weight and height one man can lift in half a minute with the one ton size of the three kinds of Yale & Towne Blocks. The "Triplex" stands in a class all by itself, and gives a maximum of speed and ease in lifting with a minimum cost of time and labor.

We have something powerful to show you at Block 29, Machinery Hall, World's Fair.

The Yale & Towne Mfg. Co.

9-11-13 Murray St., - - - New York.



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Belt, Steam and Electrically driven.

LONG & ALLSTATTER CO.

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Our machines are made in over 350 sizes and varieties.

SINGLE,
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MULTIPLE,
FOR
Railroad Shops,
Locomotive Shops,
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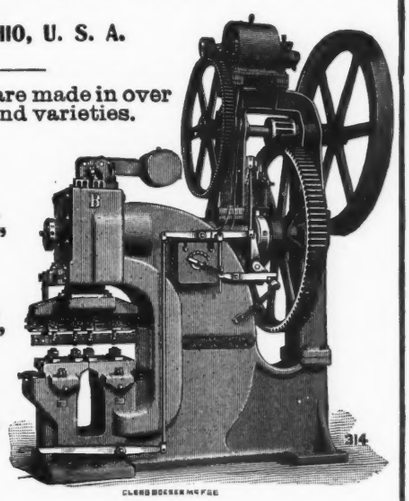
Etc.



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It's being used by Architects, Machine Builders, Electricians, Opticians, Tool Makers, Printing Press Makers—all sorts and conditions of men who use drawings.

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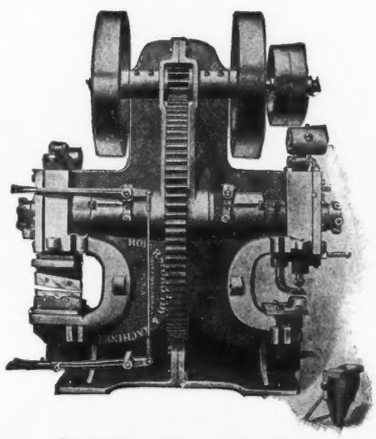

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Are You Interested in the Best

Punch and Shear?

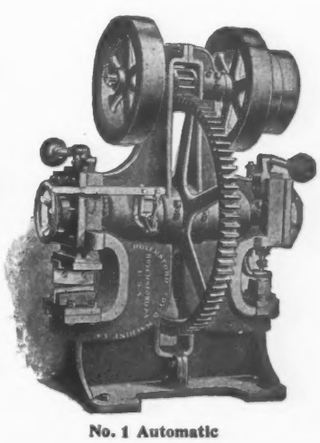
Then ask us about the

ROYERSFORD

Built for Service

Various sizes. Require little floor space.

Royersford Foundry and Machine Company
ROYERSFORD, PA.



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Established 1874

THE LARGEST AND MOST RELIABLE FOUNDRY SUPPLY HOUSE IN THE WORLD.

MANUFACTURERS

"Everything you need in your Foundry."

The S. Obermayer Company,

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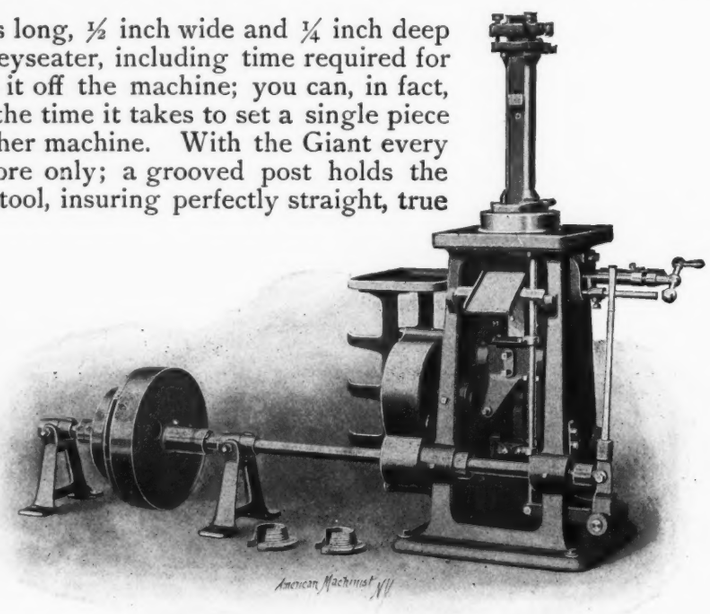
SEND FOR GENERAL CATALOGUE AND CIRCULARS.

Six-inch Keyseats in Two Minutes

You can cut a keyseat 6 inches long, ½ inch wide and ¼ inch deep in two minutes on the Giant Keyseater, including time required for putting the work on and taking it off the machine; you can, in fact, *finish* two ordinary keyseats in the time it takes to set a single piece ready for keyseating on any other machine. With the Giant every job is set and fastened by its bore only; a grooved post holds the work and forms a guide for the tool, insuring perfectly straight, true keyseats whether the hole is straight or taper, or whether the hub is faced true or left rough as it comes from the foundry. This feature alone represents a saving that will soon cover the cost of the machine.

Giant Keyseaters are built in six sizes, cover a wide range of work and are easily and quickly adjusted to different requirements.



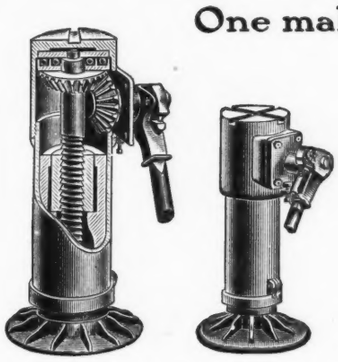
Catalogue mailed on request.

No. 4 Keyseater with 8 11-16 inch post.

Mitts & Merrill, 843 Water Street, Saginaw, Mich., U. S. A.

FOREIGN AGENTS—C. W. Burton, Griffiths & Co., London, England. Penrhyn Neville. Milano, Italy.

No Other Jack



One make of Jack is NOT "as good as another" —certainly not! No other Jack combines the safety, simplicity, efficiency and durability found in the

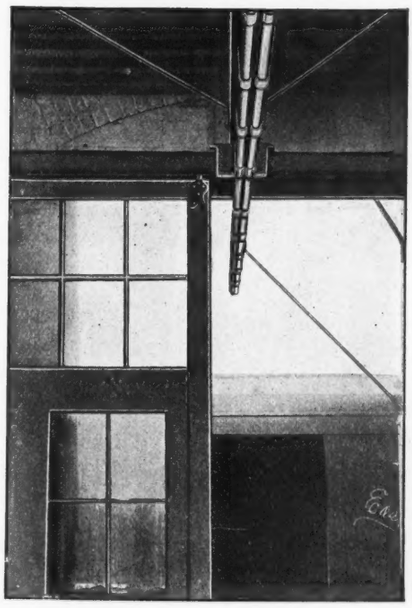
Norton Ball-Bearing Jack.

Made in 50 styles, 8 to 70 tons capacity. Adapted to all classes of service.

Manufactured by **A. O. Norton,** 286 Congress St., Boston, Mass.,

and Coaticook, Prov. Quebec, Canada.

The Easy Way It Does It



Is what impresses you most when you see the **Coburn Trolley Track** in operation. Work that would require great expenditure of time and effort if handled by main strength and muscle is safely, quickly and easily accomplished with the aid of this system, the load delivered at the desired point in the shop, foundry or factory without waste of time or labor. It not only simplifies the transportation problem but adds to the efficiency of the whole shop force.

The **Coburn Tracks** are constructed to meet varying needs, to stand hard and rough usage and will last indefinitely. The carriers are of the most up-to-date and efficient design; switches can be arranged for the most complicated tracks. Let us estimate on installing the Coburn in your plant—the expense is comparatively small—the service the highest.

Coburn Trolley Track Manufacturing Co.

Holyoke, Mass., U. S. A.

LIFE AND POWER.

What the heart is to the man the crank is to the shaper.

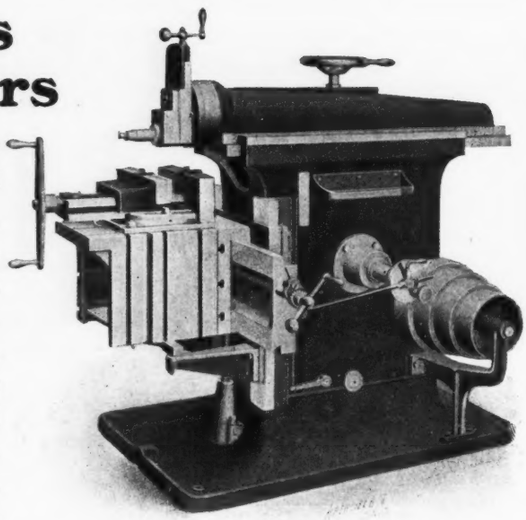
THE STOCKBRIDGE (**TWO-PIECE**) CRANK MOTION IS FOUND ONLY ON STOCKBRIDGE SHAPERS.

Stockbridge Machine Company, Worcester, Mass.

Kelly's Shapers

Cover a Wide Range of Work

and do the work accurately, quickly and with least trouble to the operator. In design they are symmetrical, strong and rigid, embracing all up-to-date improvements, and with ample power for handling heavy work.



New Catalogue shows all sizes.

The R. A. Kelly Co., Xenia, Ohio.

Planers and Shapers

Specifications, quotations and information on solicitation.

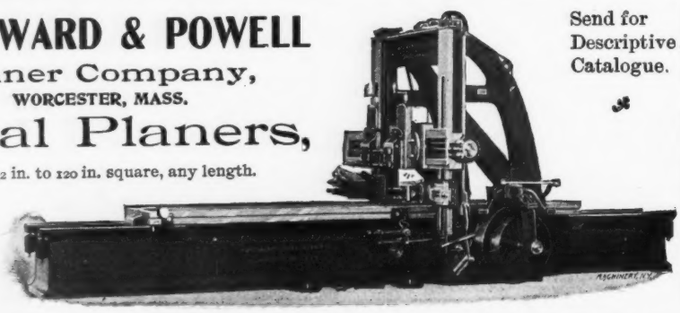
The Mark Flather Planer Co., Nashua, N. H.

WOODWARD & POWELL

Planer Company,
WORCESTER, MASS.

Metal Planers,

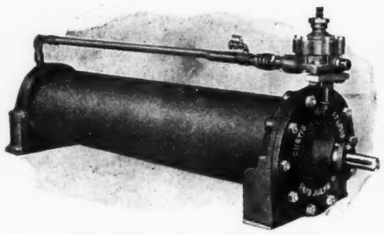
From 22 in. to 120 in. square, any length.



Send for Descriptive Catalogue.

Agents: Manning, Maxwell & Moore, New York and Chicago; Baird Machinery Co., Pittsburg, Pa.

THE CURTIS CLASS "B" HOISTS "BRACKET"



PNEUMATIC ELEVATORS
AIR COMPRESSORS

CURTIS & CO. MFG. CO., St. Louis

AGENTS—Walter H. Foster, New York. Hill, Clarke & Co., Boston. Baird Mchy. Co., Pittsburg. Strong, Carlisle & Hammond, Cleveland.

WE MANUFACTURE

SHAPERS

EXCLUSIVELY.

12 TO 32 INCH STROKE.

SMITH & MILLS,
Cincinnati, Ohio, U. S. A.

Crank Shapers

16, 18 and 24 inch Stroke.

Engine Lathes

18, 22 and 24 inch Swing.

Best material, best workmanship, best value for the money invested.

Wm. Barker & Company
Culvert and Pioneer Streets
CINCINNATI, OHIO.

Shepard's Screw Cutting Foot Lathes

will stand the most severe service. These machines are fitted with reverse head and compound rest, are extremely accurate, convenient, and easy to operate. Will cut threads 3 to 120. First class in every particular.

Circular X for full description.

Shepard Lathe Company
Cincinnati, Ohio

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A CATALOG ENTITLED

Labor Saving Tools

OPERATED BY

Compressed Air

No. 5

Just issued by

The Ingersoll-Sergeant Drill Co.

26 Cortlandt St., New York

CHICAGO, ILL. BOSTON, MASS.
CLEVELAND, O. PITTSBURG, PA.
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K2

What A Tool Does Proves What A Tool Is.

FROM the time the Cleveland Riveters and Chippers were first put on the market *they have been made the standard for comparison.*

Why buy something "just as good" as the "Cleveland"? If you buy "Clevelands" you get that which was *originally the best,* and they are the *best to-day.* In use throughout the civilized world. We have built up a large foreign trade, yet we have never sent a representative across the water. *MERIT did it.*

The Cleveland Pneumatic Tool Co., CLEVELAND OHIO, U. S. A.

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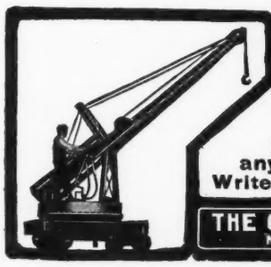

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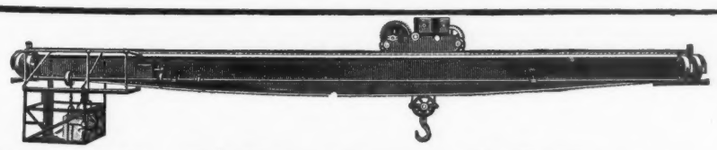
Just a Little Investigation will convince you of their superiority. 1,000 to 10,000 lbs. capacity or built to any specifications. Write us for full information and blue prints.

THE GARRY IRON & STEEL CO. CLEVELAND, OHIO.
MACHINE AND STRUCTURAL IRON WORK.



Electric and Hand Traveling Cranes. Northern Cranes Jib, Truck and Locomotive Cranes, All Capacities.

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C. W. Burton, Griffiths & Co., London, Eng., Agents for Great Britain.

Finished Machine Keys

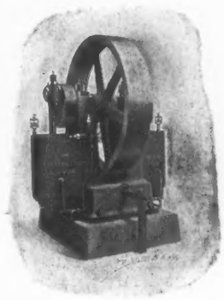
Gib and Plain Head.

All sizes carried in stock. Write for discounts.

Cheaper than you can make them. Finished "Ready to Drive."

OLNEY & WARRIN, 36 Dey St., New York.

AIR TOOLS COMPRESSORS AIR & GAS ROCK DRILLS



Machine Shop

Compressors, Steam and belt driven.

State requirements and we'll fill the bill.

Pneumatic tools of the "Imperial" type. New patterns.

CATALOG J.

RAND DRILL CO. 128 BROADWAY N.Y.

Our CRANES

are equipped with inventions of our own, which make them practically "fool-proof." Proposals will be based upon prompt deliveries, reasonable prices, and full explanation of special features.

THE NORTH PENN IRON CO.

Venango and American Sts.

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BRANCH OFFICES:

Pittsburg, 818 Frick Building. Chicago, 171 LaSalle Street.
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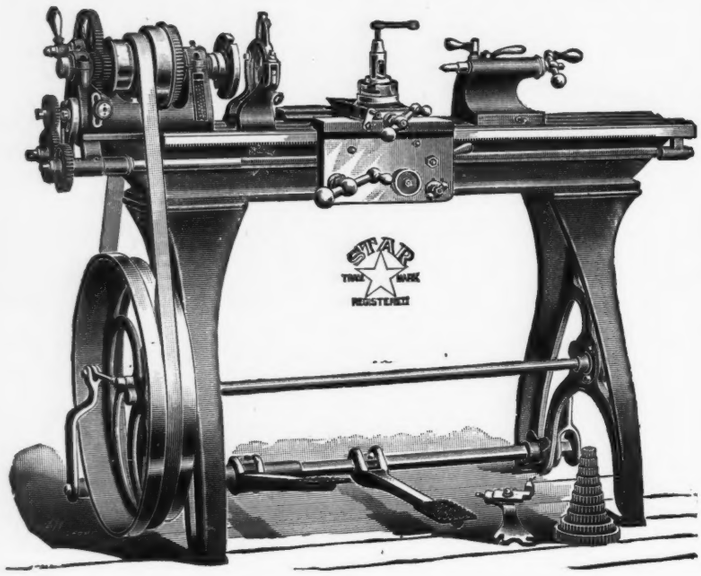
HOISTS, NEW PATENT WHIP Patent Friction Pulleys. NONE BETTER. MANUFACTURED BY

VOLNEY W. MASON & CO., PROVIDENCE, R. I., U.S.A.

Foot Power
"Star" Lathes



Are high-grade screw-cutting engine lathes, 9 and 11 inch swing, made to supply the demand for a foot power lathe containing the desirable features of the best power lathes and equal to any precision lathe for accuracy. A large number are also used with countershaft for light machine-shop and tool room service We guarantee complete satisfaction or your money back.

SOME FEATURES—Forged crucible steel hollow spindle, phosphor bearings, exclusive gear-driven reversible feeds, graduated cross feed screw. Can furnish lathes arranged for cutting metric threads, also with draw-in chuck, milling, gear-cutting and taper attachments.

ASK FOR CATALOG "B"

The Seneca Falls Mfg. Company

330 Water St., Seneca Falls, U. S. A.

AGENTS:—Montgomery & Co., New York. A. J. Wilkinson & Co., Boston. Wm. P. Walter's Sons, Philadelphia. Baird Machinery Co., Pittsburg. O. L. Packard Machinery Co., Chicago and Milwaukee. Scott Supply & Tool Co., Denver. Pacific Tool & Supply Co., San Francisco.

71

Pressed Steel **Shop Pans or Tote Boxes**

For Machine Shops and Foundries, Bolt Works, Etc.

THOUSANDS IN USE. DURABILITY AND SATISFACTION GUARANTEED.

This cut represents "A" to "F".

Made of any Gauge of Sheet Steel desired; never go to pieces as the common riveted boxes do, and always give entire satisfaction. Try samples and you would not be without them in your works at any price.

Suitable for handling bolts, rivets, nails, screws, nuts, washers, castings, ore, quartz and other substances, and for use under lathes and drill presses to catch the turnings, trimmings, borings, oil drippings, etc. Send for Catalogue.

KILBOURNE & JACOBS MFG. CO., COLUMBUS, OHIO.

These Saws Stand the Test

The proper way to test Hack Saw Blades is to cut off pieces from the same bar of steel, changing the blades to be tested on each alternate cut. Keep an accurate record of the time consumed by each blade in performing the work and the number of cuts each blade makes. If the weight or pressure on the blade is changed it should be made so as to affect both saws alike. This is the kind of test we solicit for the

Universal Hack Saw Blades.

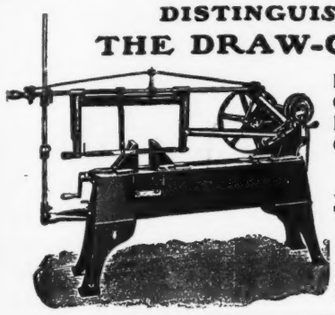
All we ask is a fair trial and if we cannot then convince even the most hardened unbeliever that our blades are all we claim for them—we have nothing more to say. Your dealer will furnish them on your order. Send for circulars and prices.

West Haven Manufacturing Company,

NEW HAVEN, CONN., U. S. A.

Sole Agents for Export,
The Fairbanks Co., 311 Broadway, New York.
78-80 City Road, London, E. C., Eng.

DISTINGUISHING FEATURES OF THE DRAW-CUT MACHINE SAW.



Draw-Cut, lessening liability of breakage.
Geared Drive, giving speed and power.
Roller Guides, insuring accuracy.
Combination Feed, Adjustable Stroke, Blade relieved on forward Stroke.
Adapted for sawing cold metal of all kinds.
Two sizes, capacities 6″ x 6″ and 10″ x 10″.
CATALOGUE?

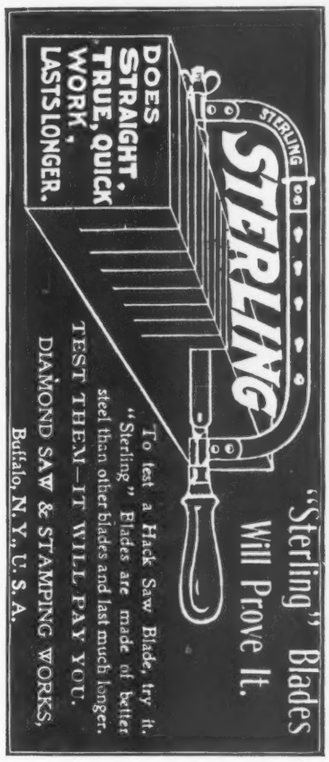
H. T. STORY
30 W. Randolph St., Chicago, Ill.

Stands the Test of Fire.

Our racks are useful most anywhere in the shop but this Pan Top Rack is meant especially for the drop forge room, for holding hot work just as it comes from the forge. The hottest forging cannot hurt it, and if it is not needed for this work it is handy for holding small parts and keeping things together generally. Made with Tray 22 x 28 or 26 x 34 inches. Regular height 36 inches, but varied if desired. Price $9.25 for the small size, $16.00 for the large one.

We make other racks that may interest you. Send for illustrated booklet.

THE NEW BRITAIN MACHINE CO.
NEW BRITAIN, - - - - - - - CONNECTICUT.


DOES STRAIGHT, TRUE, QUICK WORK, LASTS LONGER.
STERLING
STERLING
"Sterling" Blades Will Prove It.
To test a Hack Saw Blade, try it. "Sterling" Blades are made of better steel than other blades and last much longer. TEST THEM—IT WILL PAY YOU.
DIAMOND SAW & STAMPING WORKS, Buffalo, N. Y., U. S. A.

Fulton
Hack Saw
Blades

Seldom Equalled. Never Excelled.

MONTGOMERY & CO.
105-107 Fulton St, New York City.

If you are interested in the best

Finished Machine Keys
Keyway Cutters
and
Draw Cut Shapers

WRITE FOR CIRCULARS TO THE
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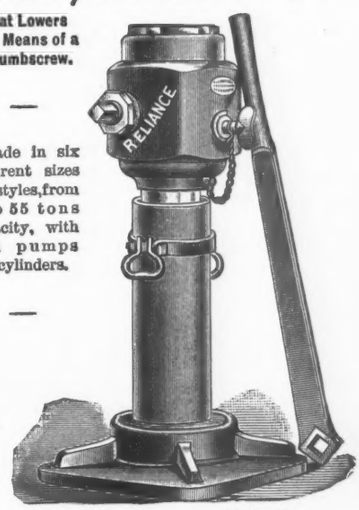
Or New York Office, 126 Liberty Street

The Hydraulic Jack

That Lowers By Means of a Thumbscrew.



Made in six different sizes and styles, from 8 to 55 tons capacity, with steel pumps and cylinders.

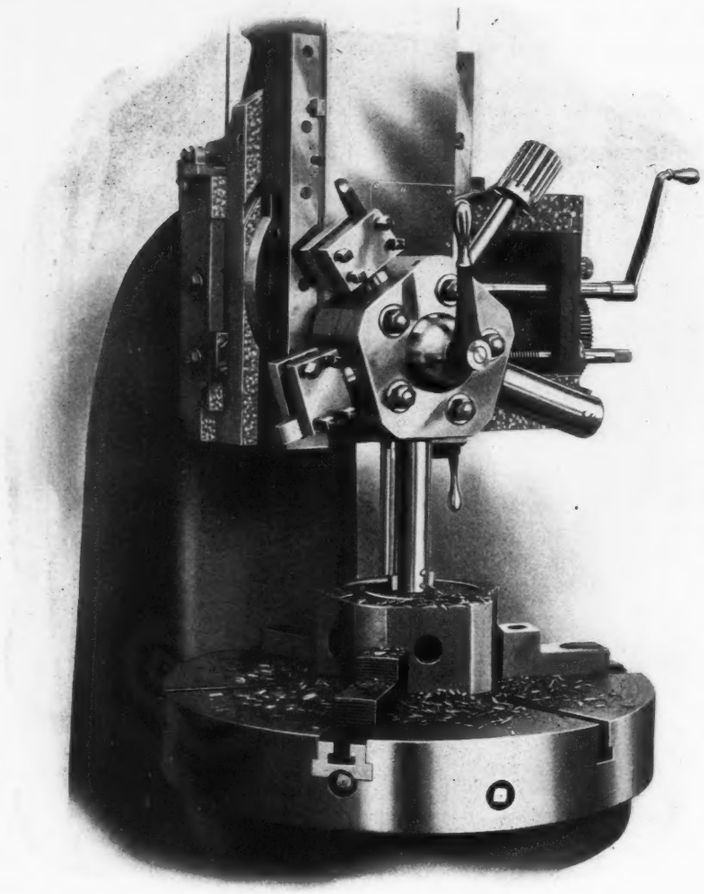
For Illustrated Booklet and Price-List address the Manufacturers,
DIENELT & EISENHARDT,
1304 North Howard Street,
Philadelphia, Pa.

Chicago Adjustable Boring Tools

will save time and money in every shop where they are used. Fit the tool post of any make or size lathe over 12-inch swing, and hold any size bar from ¼ to 2½ inches.

Illustrated catalogue on request. *Tool sent on approval.*

C. A. NORDQUIST, Manufacturers' Agent, **39 W. Randolph St., Chicago, Ill.**



Five Operations

performed on one piece without stopping the machine or changing a tool.
Duplicate pieces made by the thousand Better and faster work than any lathe can do.
Send for illustrated bulletin of this

34-inch Mill

Other sizes, 44″, 53″, 60″, 65″ and 72″.

COLBURN MACHINE TOOL CO.
Franklin, Pa., U. S. A.

OUR MILLS ARE CARRIED IN STOCK BY THE FOLLOWING AGENTS:

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Are your Mailing Lists up to date?

During the dull summer months manufacturers have time to overhaul their lists of prospective customers and get them in shape for an active fall campaign. A copy of the MECHANICAL INDEX would prove a most effective aid in this work, because it comprises a complete directory and encyclopedia of all manufacturers in the United States of mechanical tools and appliances operated by steam, electricity, water, air, hand or foot power.

It is the most comprehensive index to these trades that has ever been published, containing two thousand five hundred and fifty-four different classifications, covering every kind of machine tool, metal working machinery, wood working machinery, electrical appliance, steam appliance, railway appliance, agricultural machinery, textile machinery, mining machinery, hoisting and conveying machinery, printing machinery, foundry equipment, and a hundred other classes of mechanical appliances.

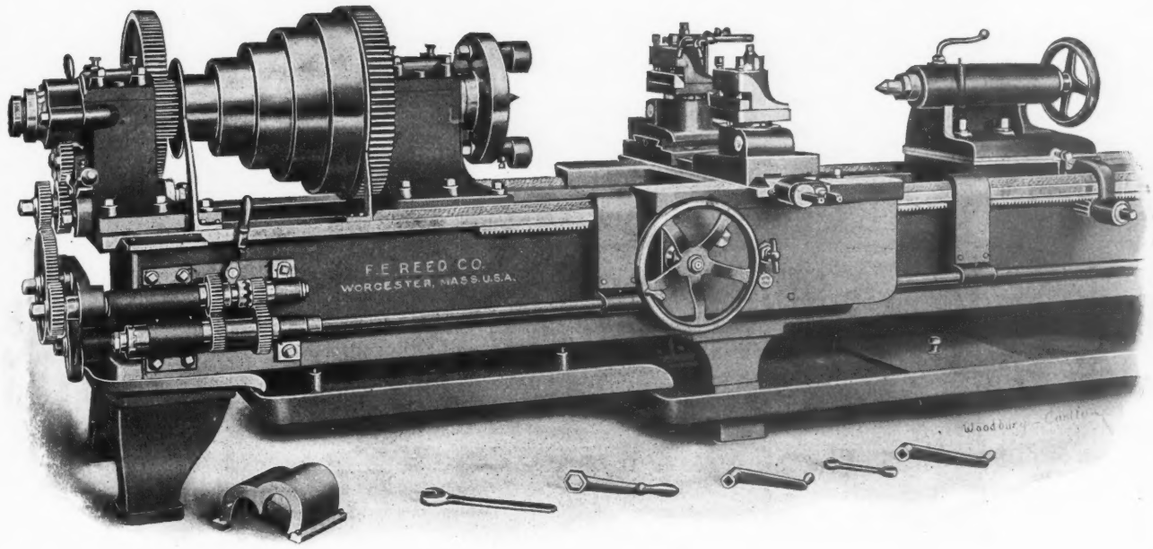
☞ *See page fifty-four for price and particulars.*

The Industrial Press, Publishers, 66 West Broadway, New York.

Reed Special Turning Lathe

With Two Patented Elevating Tool Posts

Newly Designed to Meet the Demands of the Rapid Turning Steels



This lathe is designed for reducing large amounts of metal at one turning, using the high speed turning steels, and is an unusually powerful tool,—stiff and strong.

A special feature of this lathe is the Rest. It is provided with two patented elevating tool posts, each having our universal tool holder, in which any size of steel can be used to advantage, and so made that they admit of adjustment up and down while the tool is under cut. Each tool post is moved from the front by separate screw, and the rear tool post is provided with a screw for adjustment crosswise of the rest. These tools can both be used to turn to the same diameter by dividing the chip; or can be used to largely reduce the diameter, removing large amounts of stock, working one tool in advance of the other, each tool turning to a different diameter.

We solicit your inquiries regarding these splendid lathes. We make them in four sizes.

F. E. REED COMPANY, Worcester, Mass., U. S. A.

OUR AGENCIES: Manning, Maxwell & Moore, New York, Philadelphia, Chicago, Cleveland, Pittsburg, Boston. Carey Machinery and Supply Co., Baltimore. Syracuse Supply Co., Syracuse. Levi Booth & Sons, San Francisco. McArdle-Parker Machinery Co., New Orleans, Birmingham. A. R. Williams Machinery Co., Toronto. Chas. Churchill & Co., London. Van Rietschoten & Houwens, Rotterdam. Fenwick Freres & Co., Paris. Graham Bros., Stockholm. C. & J. W. Gardner Co., St. Petersburg.

Nine Times out of Ten

Made in sets of nine and will fit any sized hole from one to seven inches. Catalogue for full particulars.

The time required for a man to hunt through a pile of solid mandrels for one just the right size for the job in hand, would be sufficient to get the work half done with **Nicholson's Expanding Mandrels.** Isn't this worth investigating? Nicholson's Mandrels are strong, durable, compact and convenient. All parts interchangeable.

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FOREIGN HOUSES—C. W. Burton, Griffiths & Co., London. Schuchardt & Schutte, Berlin, Cologne, Vienna, Brussels, Stockholm, St. Petersburg.

"REECE" ROUND ADJUSTABLE DIES

are perfectly reliable—never twist, never cut taper threads or double threads, and can be adjusted by any one. We make and carry in stock many sizes and threads. Catalogue for details.

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A QUESTION OF IMPORTANCE

that should interest every progressive manufacturer is Electric Welding, as it is both practical and profitable. Welds are made where welds can't be made by hand. You can make us prove this if you'll send us a job.

What we do—we do right. *What we say we do—we do.*

The Standard Welding Co., Cleveland

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THE WAY TO MAKE MONEY IS TO SAVE MONEY.

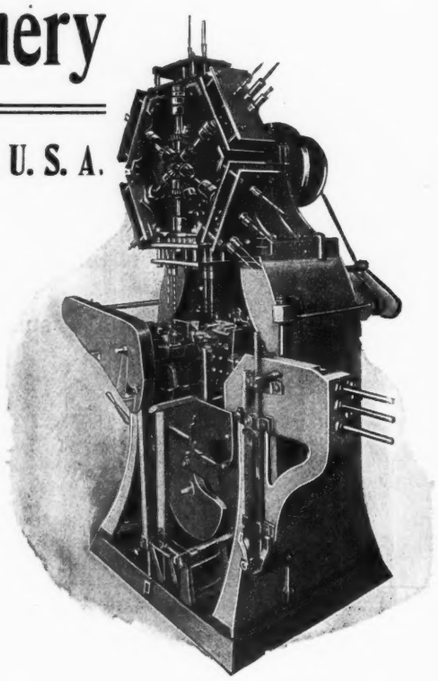
Automatic Money-Making Machinery

BUILT BY

The National Automatic Tool Co., Dayton, Ohio, U. S. A.

Automatic Multiple Spindle } Drilling, Reaming, Facing, Boring, Tapping } One Machine does it all.

It drills from all sides and angles. Drills holes close together or far apart. Drills all size holes from No. 60 wire gauge to 1 1-4 inch. Runs every drill at its own proper cutting speed, and maximum feed.



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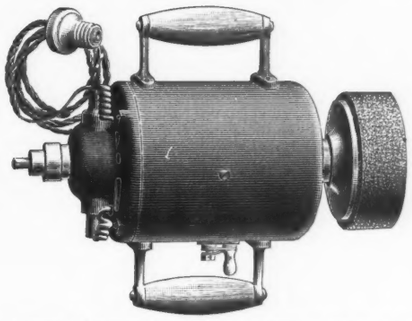
A HAND-Y TOOL

Something New Under the Sun.



The "Hisey" Portable Electrical Driven Hand Buffer or Grinder

Weight 14 pounds. Dimensions 4-in. x 7-in.

We here illustrate a new tool which can be adapted for buffing, polishing, grinding, sanding or other work of this nature. Any kind of wheel can be attached. Being light in weight, it can be carried anywhere, as any length cord can be used. It is under immediate control of the operator at all times. The motor is enclosed and dust-proof. The bearings are adjustable to wear. SENT ON TRIAL.

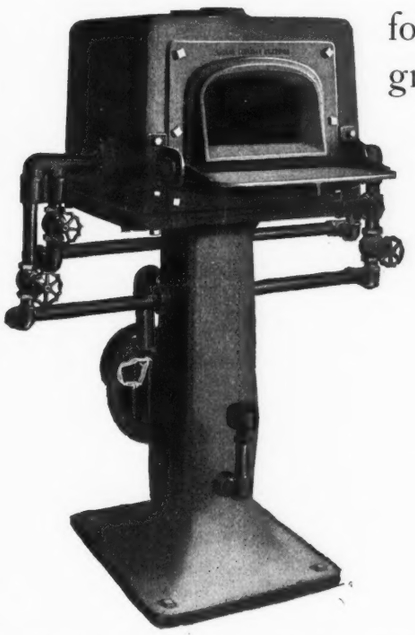
Power from any incandescent lamp socket, direct current.

Write for 1904 Catalogue on "Hisey" Portable Electrical Grinders and Hand Drills.

The Hisey-Wolf Machine Co., Cincinnati, Ohio.

In Stock by Foreign Agents—Chas. Churchill & Co., London, Birmingham, Manchester, Glasgow. Schuchardt & Schutte, Berlin, Cologne, Vienna, Brussels, Liege, St. Petersburg, Stockholm, Milano, Bilbao. J. Lambercier & Co., Geneva, Switzerland.

The Stewart Gas Blast Furnace



for heating, tempering and hardening high grade steel tools or work of similar character.

Heats the steel with absolute evenness, entirely removes the element of uncertainty, does the work in half the time and requires only a fraction of the care demanded by other methods.

Compact, convenient, economical in the use of gas, makes no dust or ashes and heat is under perfect control at all times.

We make 55 styles and sizes of Gas Furnaces.

Chicago Flexible Shaft Co., La Salle Ave. & Ontario St., Chicago, Ill.

FOREIGN AGENCIES—Niles Tool Works, 23-25 Victoria St., S. W. London. Fenwick Freres, 21 Rue Martel, Paris, France, Agents for France, Italy, Belgium, Spain, Portugal and Switzerland.

A Proper Speed For Every Need

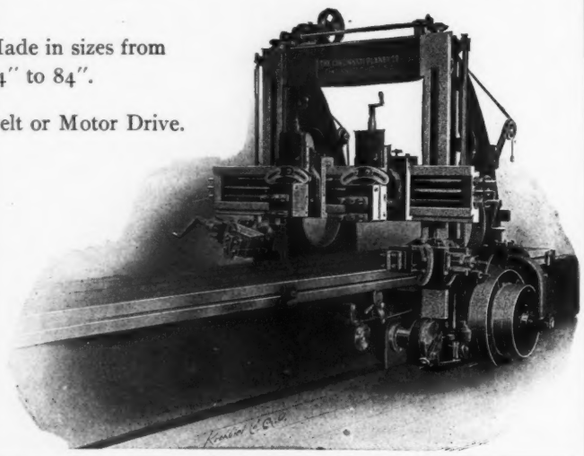
is possible with the Cincinnati Variable Speed Planer, and every facility for handling modern work. With our new speed box you can obtain six cutting speeds, 15 to 80 feet per minute, with a uniform return of 80 feet; changes made instantly while machine is in operation.

Catalogue for full description.

Cincinnati Planer Co., Cincinnati, O.

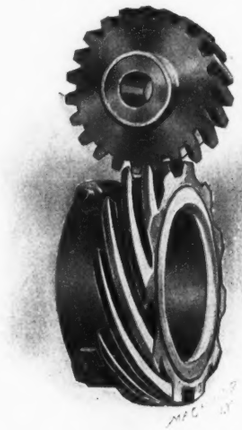
Made in sizes from 24" to 84".

Belt or Motor Drive.



GEARING

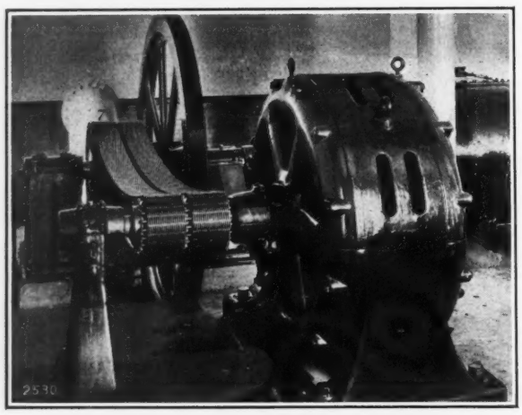
OF ALL DESCRIPTIONS AND OF ANY MATERIAL.



Send us your Gear Cutting, we are equipped to turn out the best work promptly and at fair prices.

The Earle Gear & Machine Co.

N. E. Cor. Oxford and Mascher Sts., Philadelphia, Pa. 1318 Land Title Building.



RENOLD SILENT CHAIN

500 H.P. Drive, Operating Gas Blower. Speed, 1900 ft. per Minute. Arlington Mills, Lawrence, Mass.

Two strands of chain running parallel are employed in cases where one strand is insufficient to transmit the power. The load is properly distributed between the chains, and the wear of the chains equalized by the use of Spring Center Wheels on either driving or driven shafts.

After Comparative Tests, Renold Silent Chain has been selected by U. S. Navy Department for their automatic rammers. Write for Booklet "Y".

New York, 49 Dey Street. **LINK-BELT ENGINEERING CO.,** *Park Bldg., Pittsburg.*
PHILADELPHIA.
Chicago. **LINK-BELT MACHINERY CO.,** *Chicago.*

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concerning any kind of machinery or supplies desired, addresses of manufacturers, etc., will be furnished to any of our readers on request.

Address, Information Department
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66-70 West Broadway, New York

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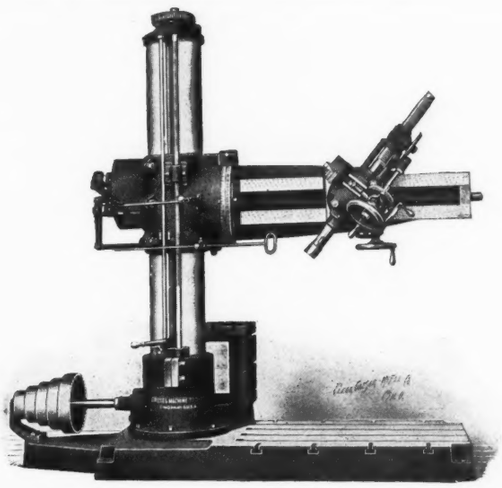
ARE COPIED BODILY IN EUROPEAN COUNTRIES



This is flattering and shows the merits of our tools. Fortunately these *copies are* like the tools *we built five years ago* and cannot be compared with our new and redesigned machines.

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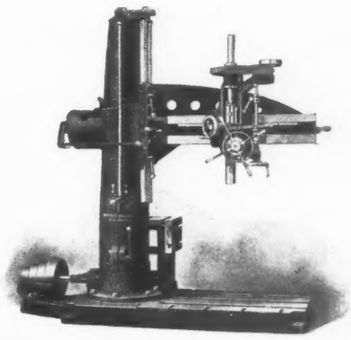

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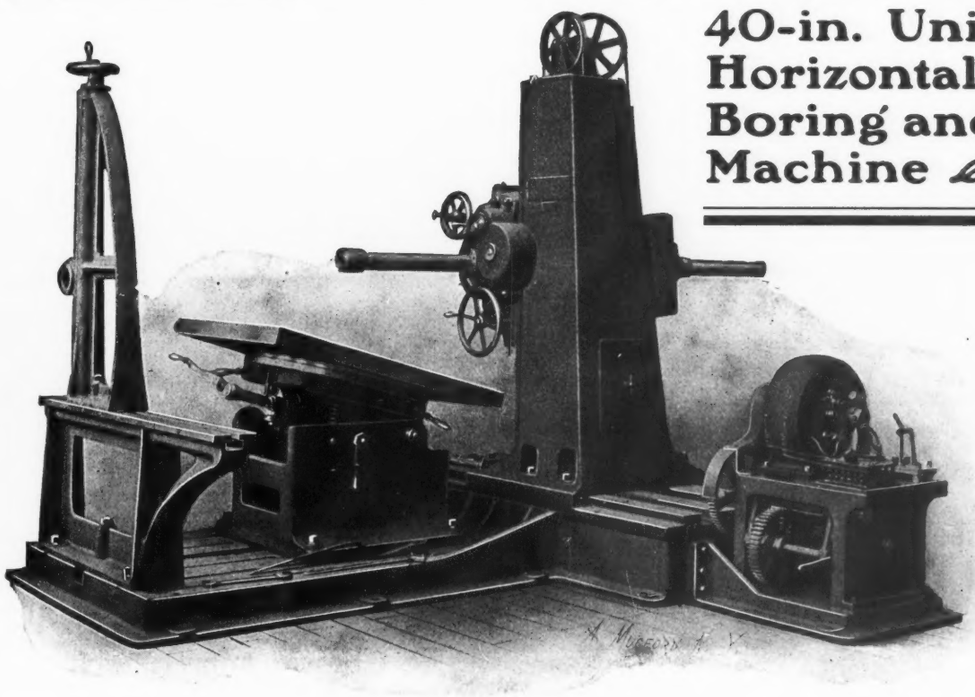

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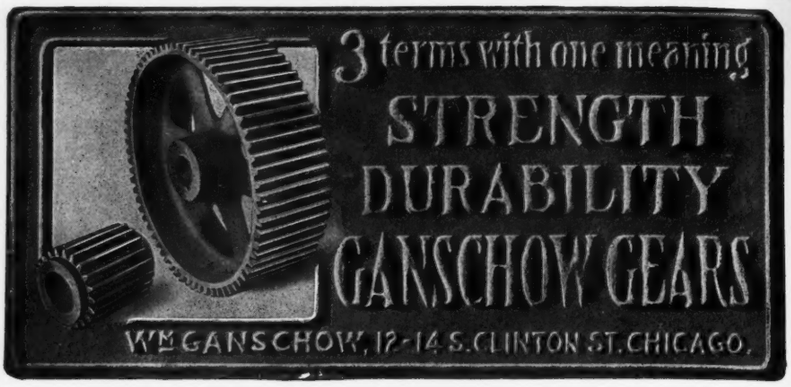

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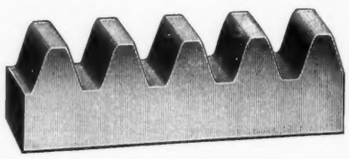

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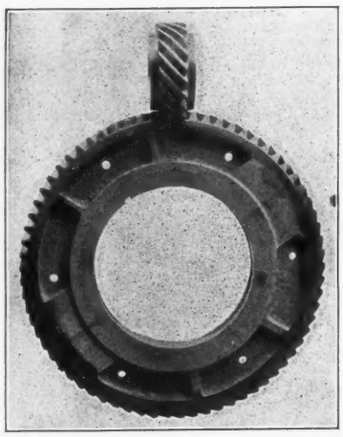

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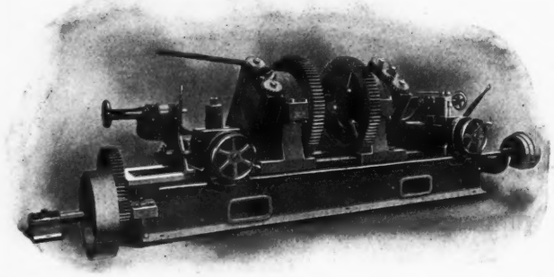

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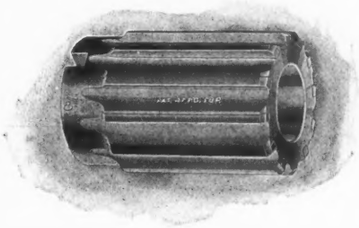

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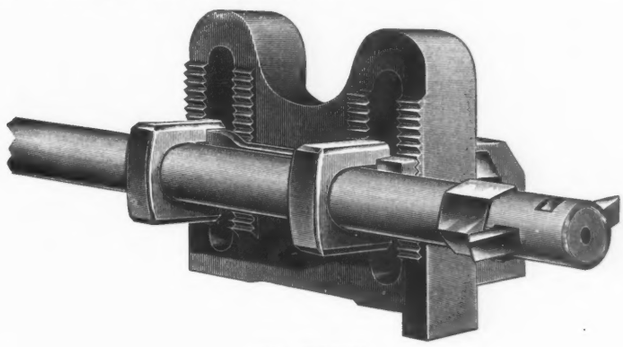

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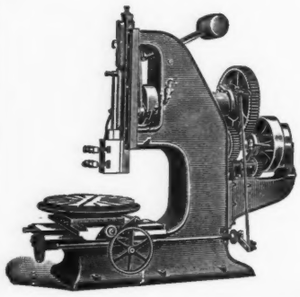

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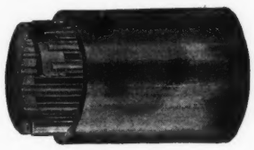

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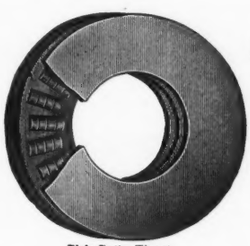

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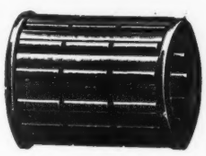

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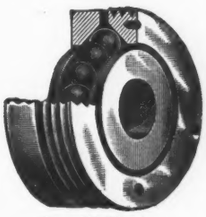

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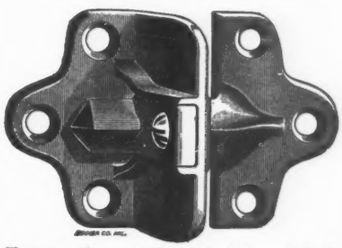

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19 in. x 12 ft., Pratt & Whitney.
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22 in. x 8 ft., Plain, Niles.
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38 in. x 42 in. x 14 ft., 4 hds., Pond.
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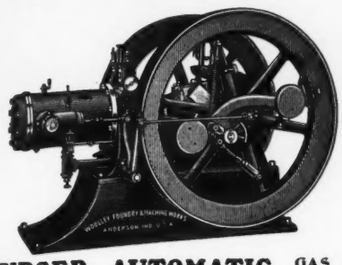

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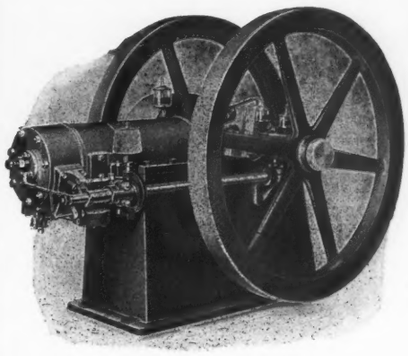

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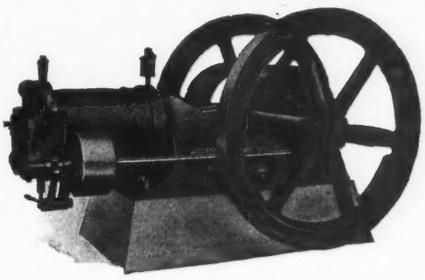

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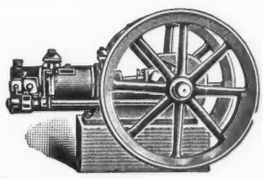

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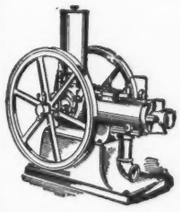

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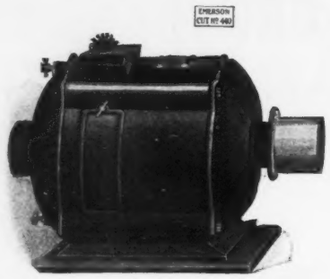

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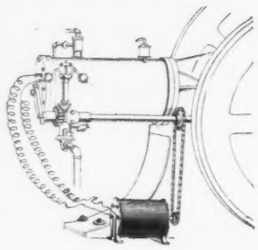

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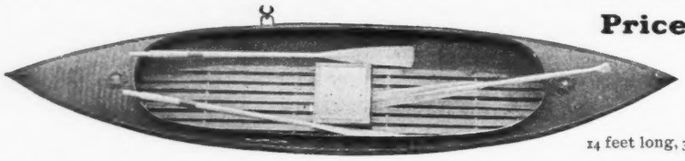

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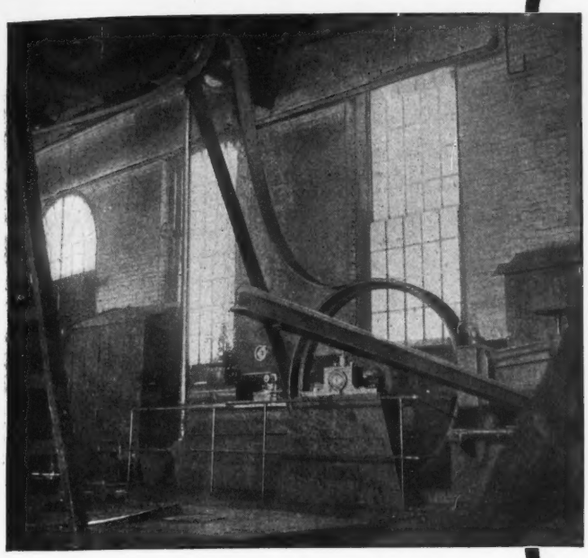

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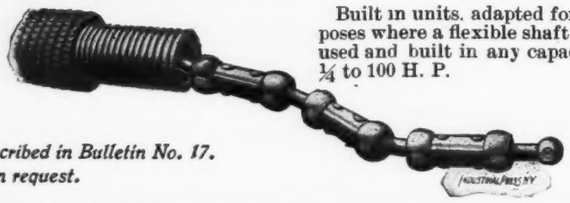

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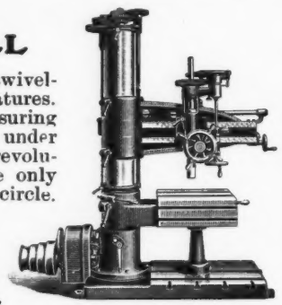

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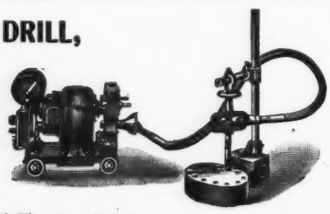

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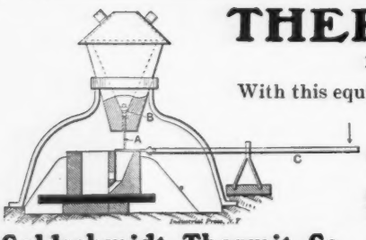

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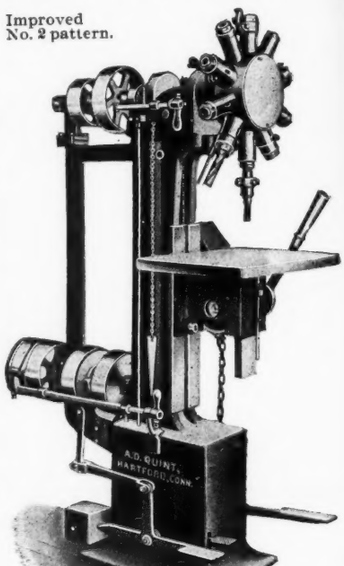

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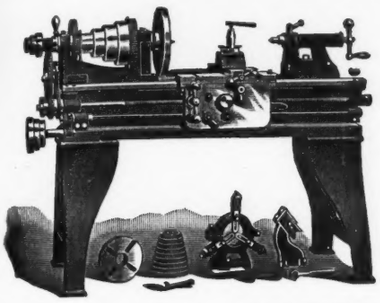

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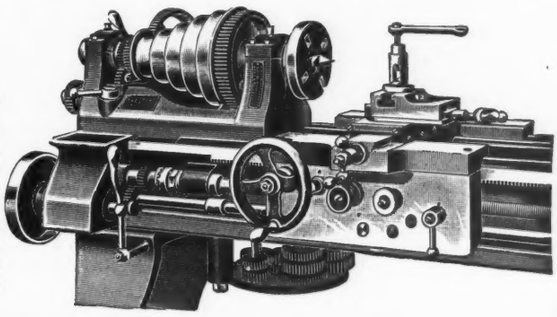

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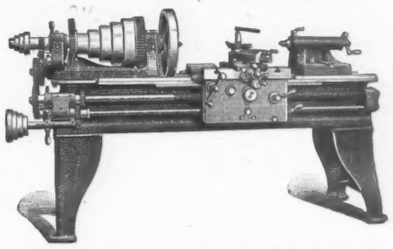

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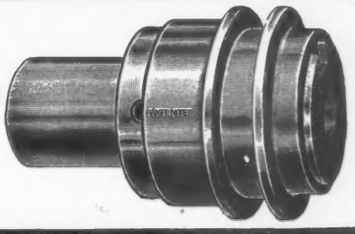

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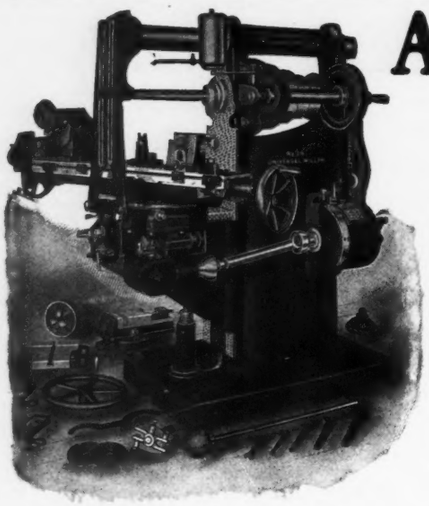

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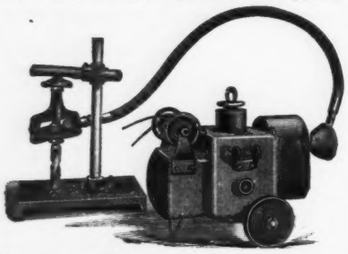

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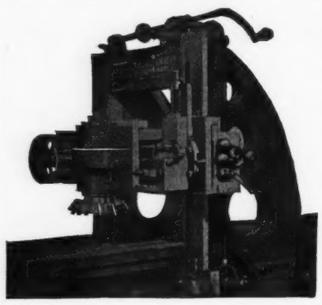

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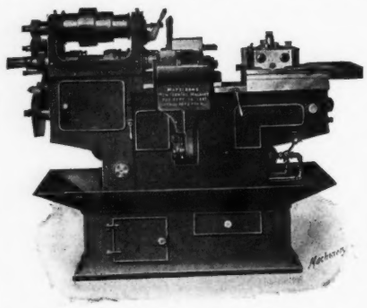
THE NEW FORMING MACHINE.

MULTIPLE SPINDLE. FULL AUTOMATIC

For all kinds of screw machine work



Brand New Shop. Brand New *Up-to-Date* tools, equiping same throughout especially for the purpose of building the **New Forming Machine.**

The demand for this excellent and rapid machine has forced more rapid production of it It could not be otherwise.

A machine which is very strong and durable, that will execute from two to four times the quantity of work that any single Spindle Machine can turn out, and do the work more accurately cannot be crowded into your works too soon, no matter how many other automatics you have in use.

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JAMES D. MATTISON,
253 Broadway, NEW YORK, U.S.A.

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C. P. Mingst, Evansville, Ind.
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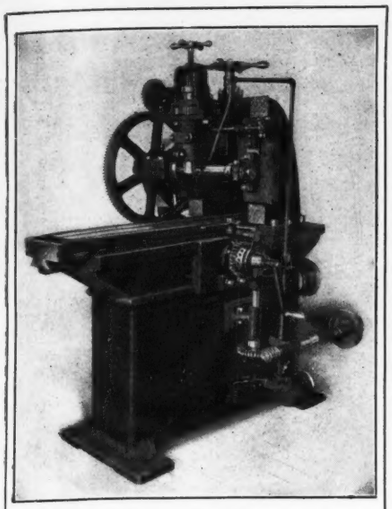
Mingst Lathe Tools

Strong, durable, up-to-date. Blades made from finest Self-hardening Steel and guaranteed satisfactory.



Keyseat Milling Machine

Built in Two Sizes, with or without Routing Attachment.

Powerful, Efficient and Convenient.

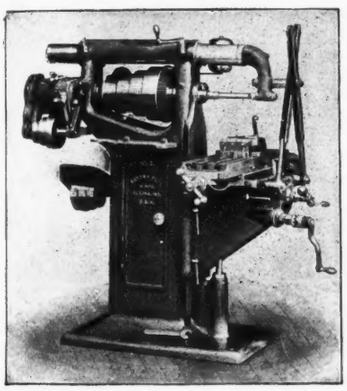
The best machine for plain or round-end Keyseats.

Can also be used on a large variety of plain milling.

John T. Burr & Son

34 South 6th Street, BROOKLYN, N. Y.

Aurora Millers.



Good work in quick time

is the record of our No. 2 Plain Milling Machine. Strong, convenient, fitted with all improvements.

Fully described in Catalogue No. 7.

AURORA TOOL WORKS,
Aurora, Ind., U. S. A.

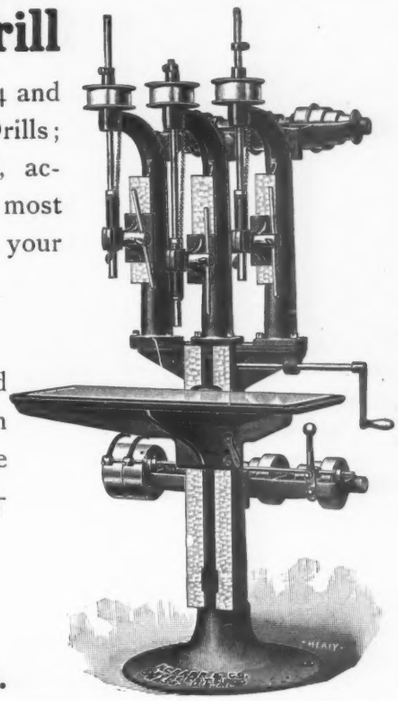
Auburn Ball-Bearing Co.

BEARINGS FOR ALL PURPOSES

18 COMMERCIAL ST., ROCHESTER, N. Y.

Three Spindle Drill

The engraving shows the 2, 3, 4 and 5 spindle style Barr Upright Drills; particularly valuable for rapid, accurate work and one of the most profitable tools you can put in your shop.



Barr's Drills

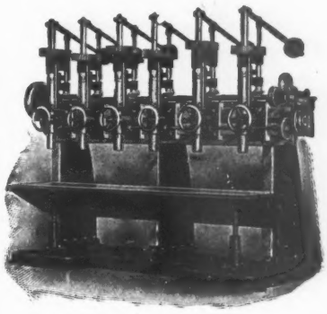
include thirty styles of single and multiple sensitive drills, each one a perfect example of fine drill construction and embodying all recent improvements.

Every drill warranted.

Circulars on request.

H. G. Barr, Worcester, Mass.

The No. 5 Independent Feed Multiple Drill



will drill six 2-inch holes simultaneously.

Send for latest catalogue, our line of

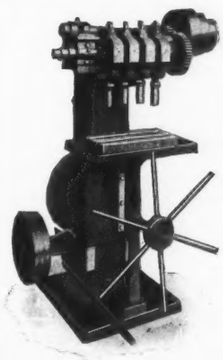
Multiple Drills

is complete, and we can give you regular machines for any size work. Spindles independent in feed and adjustment.

Exhibition at World's Fair, St. Louis, Block 9, Palace of Machinery.

Foote, Burt & Co., Cleveland, Ohio, U. S. A.

Manning, Maxwell & Moore, Agents, New York, Boston, Philadelphia, Pittsburg, Chicago.



A Working Drill

is the kind for the busy shops, and our **No. 5 Gang Drill** is essentially a worker. It is particularly strong and rigid in construction, convenient in operation and furnished with all improvements. Spindles adjust to within 2½″ of each other, and out to 13″; spiral gear drive; table counterbalanced, rack and pinion feed and automatic stop.

Send for catalogue of full line, we make Gang Borers, Speed Lathes, Patterns, Special Machinery.

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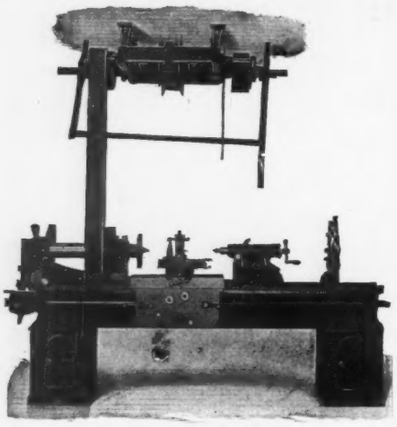

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Used in connection with 20" iron working lathe, taking the place of the usual step cone, permitting every graduation of speed between fast and slow, and increasing the efficiency of the machine fully ten per cent.

The "Reeves" is applicable to almost every class of machine requiring variable speed.

May we send you catalogue?

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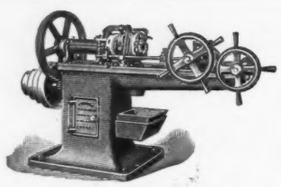

The "STANDARD" Bolt Cutter

THE OLD RELIABLE

Does perfect work.
Excels in durability.
Fully guaranteed.

Nut Taps and Dies

THE NORWALK MANUFACTURING CO.
Norwalk, Ohio.

The Boyd Sensitive Drill

For high speeds on small drilling. Capacity from ¼ to 0, and will drill to center of 10-inch circle. Spindle speeds from 500 to 4500 revolutions per minute. No countershafts, no loose pulleys. Minimum vibration. *Circular on request.*

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73-75 Jackson Boulevard,
CHICAGO, ILL.

Frictionless Roller Bearings
for Line Shafting

Save 25 to 50 per cent. in friction load.

A money saver, an oil saver and a factor in reducing fire risks. Write for catalogues and discounts.

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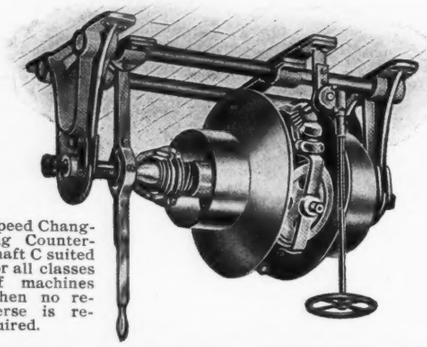
THE ADVANTAGES AND ECONOMY OF OUR SPEED CHANGING TRANSMISSION



Speed Changing Countershaft C suited for all classes of machines when no reverse is required.

are self evident. It permits your machines to be run at the speed to suit varying conditions; increases the output materially; is applicable to all classes of machines; simple, accurate, durable and fully guaranteed.

Write for special circulars.

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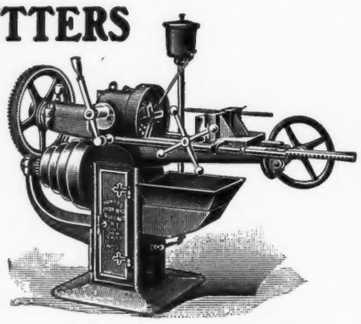
SCHLENKER BOLT CUTTERS
Cut a Clean and Perfect Thread

Send for New Catalogue

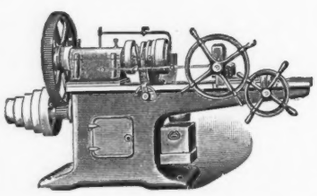
Burdict Headers,
Hot Pressed Nut Machines,
Threaders, Pointers,
Nutters, Tappers.

A full line manufactured by

HOWARD IRON WORKS
Buffalo, N. Y., U. S. A.



Schlenker Bolt Cutter No. 5½



Bolt Cutters and Nut Tappers.
ALL SIZES.

Single and Multiple Spindle, either belt or motor driven

The Reliance Machine and Tool Company,
Cleveland, Ohio.

Emery Wheel Dressers and Cutters
Cutters uniformly tempered. Made of the best Tool Steel and not stamped but milled.

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TRADE STANDARD TOOL CO. MARK

The STANDARD PATENT EMERY WHEEL DRESSER

The Best Tool Made for Refacing and Truing Solid Emery Wheels

None better adapted for doing work well and economizing time.

Tool is 12" long over all. Size of cutter 1¼" by ¾".

Circular No. 118½

Manufactured by

The Standard Tool Company

Cleveland New York

TRADE STANDARD TOOL CO. MARK

Northampton Emery Wheel Co.

LEEDS, MASS., U. S. A.

20-inch Water Tool Grinder.

Base on floor 16 in. x 24 in.

Emery Wheel, 20 in. x 2½ in.

Weight 600 lbs.

The pump on this grinder is entirely above the water, cannot leak, requires no packing, and can be stopped and started at will.

Catalogue N shows our full line of Emery Wheels and Emery Wheel Machinery. Mailed free.

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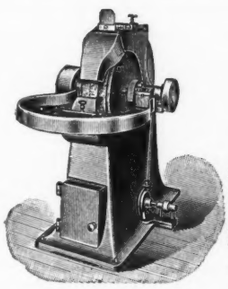

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Surface Grinders,
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Polishing Machines
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Universal Grinders.

Special attention given to the manufacture of Emery and Corundum Wheels for wet grinding.

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STENCILS-BURNING BRANDS
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ACCURATE GAUGES

STANDARDS FOR ACCURACY

For the production of duplicate parts, and maintenance of STANDARD sizes in the machine shop. Various styles carried in stock.

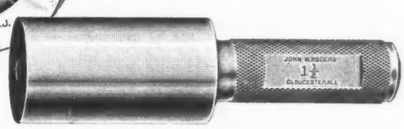

Fig. 27

Special Gauges and Small Tools made to order,

The John M. Rogers Boat, Gauge and Drill Works

GLOUCESTER CITY, N. J., U.S.A.

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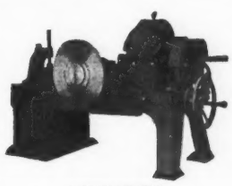
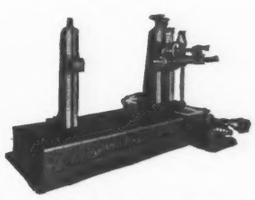


PATENTS PENDING

No. 3 Bar Cold Saw



No. 2 Horizontal Floor Boring Milling and Drilling Machine

PATENTS PENDING

No. 2 I Beam Cold Saw

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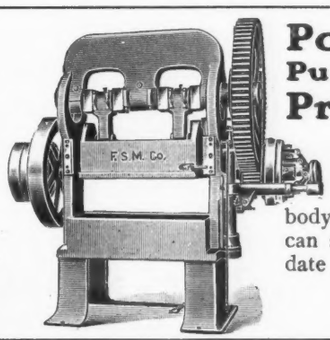
ESPEN-LUCAS MACHINE WORKS

Broad and Noble Sts., Philadelphia, Pa.



Power Punching and Stamping Presses

We have a large line of different designs and sizes, they are all good. Material used can be no better and they embody all the best features that long experience can suggest to make them suitable for up-to-date demands. Send for descriptive circular.

Falkenau-Sinclair Machine Co.
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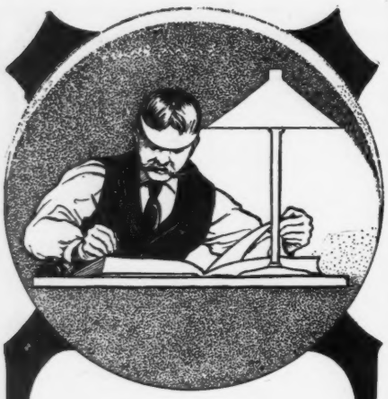

After all is said, money is the most potent force in the world, and that's why so many shops use

CARBORUNDUM

Grinding Wheels. They save money, because they do the work so much quicker and better and last so much longer than any other abrasive.

Grinding Wheels of all sorts and sizes — Sharpening Stones — Paper and Cloth — Powders and Grains for polishing.

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CARBORUNDUM COMPANY
NIAGARA FALLS, N. Y.

Fulton
Emery Grinders

Made in sizes from 8" to 18"

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105-107 Fulton St., New York City.

"THE STERLING" PAT. APR. 10 1883
STERLING
EMERY AND CORUNDUM WHEEL

Sterling Wheels

for all grinding purposes.

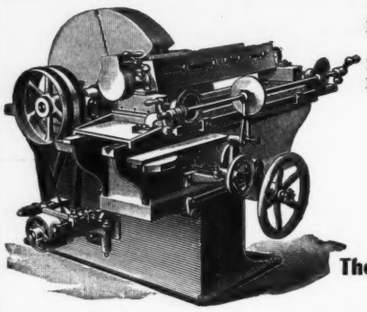
Many styles and sizes. Used wet or dry.

Emery or Corundum.

Exhibit at the World's Fair, St. Louis, Aisle C., Palace of Machinery.

Sterling Emery Wheel Mfg. Co.
Tiffin, Ohio

HEAVY AUTOMATIC KNIFE GRINDER



Emery Wheel 36" x 2" or Cup Wheel 24" x 8" x 2"
Built for Business
17 Sizes, for Knives from 20" to 180" long

The strongest and heaviest knife grinder on the market. Gives better work, more of it and is the cheapest machine in the end.
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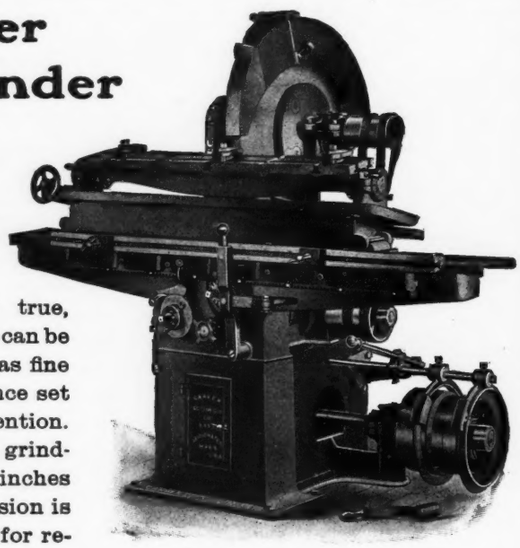
The Bridgeport Safety Emery Wheel Co., Inc.
BRIDGEPORT, CONN., U. S. A.

The Carver Knife Grinder



is a new and improved machine with automatic features, designed for grinding planing, paper cutting, or other knives which require an absolutely true, straight edge. The feed can be set to grind as fast or as fine as desired, and when once set requires no further attention. Adapted for wet or dry grinding. The wheel is 26 inches by 1½ inches and provision is made for compensating for reduction in size after long wear.

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"ABRASIVE" **THE WHEELS THAT "CUT"** "ABRASIVE"

We guarantee satisfaction.

ABRASIVE MATERIAL CO.
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THE ABRASIVE MATERIAL CO. PHILADELPHIA PA.

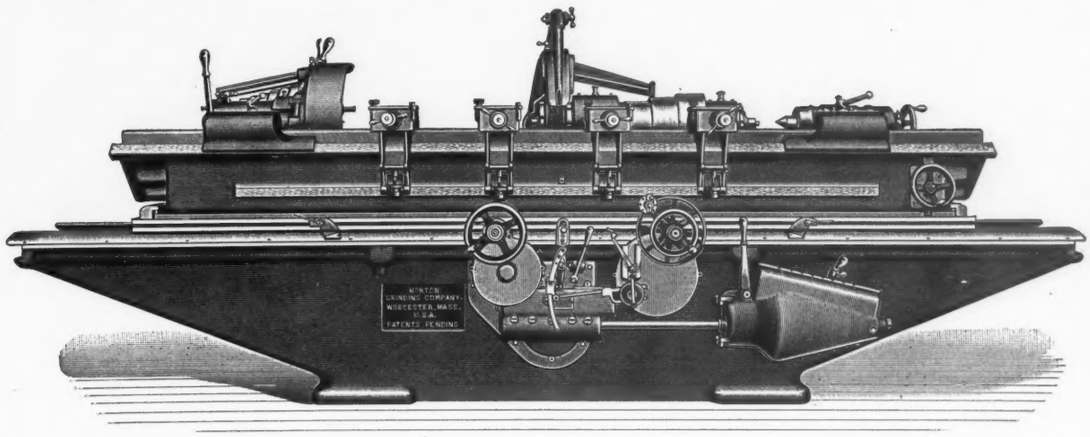
WESTERN BRANCH.
54 West Randolph St., Chicago.

Work equally well wet or dry.

Results are what you want from your **EMERY WHEELS.**

Write us for prices and samples.
HAMPDEN CORUNDUM WHEEL COMPANY,
Springfield, Mass.

NORTON PLAIN GRINDING MACHINES.



Built in several sizes for grinding work up to eighteen inches diameter by fourteen feet in length, and weighing up to seven thousand pounds.

In addition to the manufacture of grinding machinery, we make a specialty of machine grinding, and machine ground parts.

COMPLETE CATALOGUE FREE.

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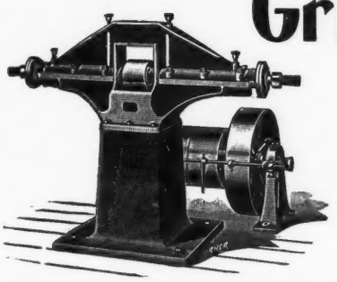
Ludw. Loewe & Co., Ltd., London, Berlin, European Agents.

Emery Wheels and Grinding Machinery



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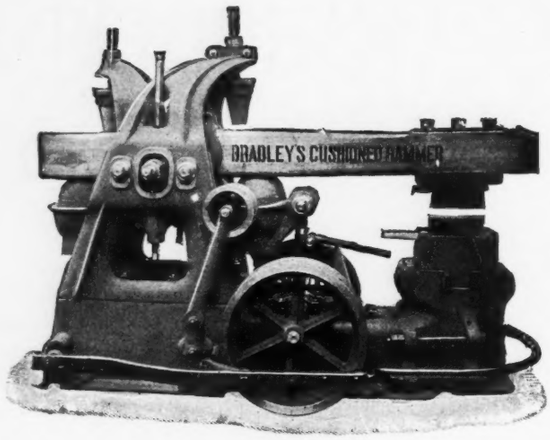
THE SAFETY EMERY WHEEL COMPANY, Springfield, Ohio, U. S. A.

The wheel that does the best work and does it in the shortest time is the wheel for the profit producing shop.

The New Corundum Wheel

has proven 50 per cent. more efficient than any other abrasive wheel on the market. We leave the rest to you.

THE VITRIFIED WHEEL CO., Westfield, Mass.



The Bradley

Cushioned Helve Hammer

is in a class by itself. There is no other Cushioned Helve Hammer.

If your work is continuous, like plating, drawing, swaging, collaring, welding or spindle making, with infrequent changes in size of material or if it is die work where perfect accuracy and the finest finish are imperative, there is no other Hammer made that can compare with it in quantity of output, durability, controlability or any other feature. Made with heads weighing 15 to 200 lbs.

More Bradley Hammers are sold each year than of all other power Hammers combined. Send for circulars.

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The Bradley Cushioned Helve Hammer. **The Bradley Upright Helve Hammer.**
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Forges for Hard Coal or Coke.

C. C. Bradley & Son, Syracuse, N. Y.

FOREIGN AGENTS: Schuchardt & Schutte, Berlin, Cologne, Paris, Vienna, Brussels, Stockholm, St. Petersburg. Buck & Hickman, Ltd., Whitechapel Road, London.

STEAM HAMMERS 250 lbs. to 10 tons Falling weight. Made with Steel Frames for severe service.

Fixed and Portable Types. Packed with Hemp.

HYDRAULIC RIVETERS

We also make
Hydraulic Cranes, Presses, Accumulators, Pumps, Fittings.
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JUST THINK OF IT!

Our Shaft Hangers are
50% Lighter and 200% More Rigid
besides being
Much Handier
than any Cast Iron Hanger. They are
Much Cheaper to Erect
and with it all, they are
Unbreakable;
but of course they are made of
Pressed Steel.
Get it of your dealer or direct from

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Agents in all the principal Cities in the United States.

Fit up your machines with the
U. S. STANDARD PUNCHES

The Best System on Earth for
PUNCHING IRON AND STEEL.

Scranton Power Hammers

COST LESS than any other hammer that will produce an EQUAL AMOUNT OF WORK.

By our construction we avoid breakdowns.

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The Scranton & Co.
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The Beaudry Champion Power Hammer.

For All Classes of Work

Acknowledged The Best.

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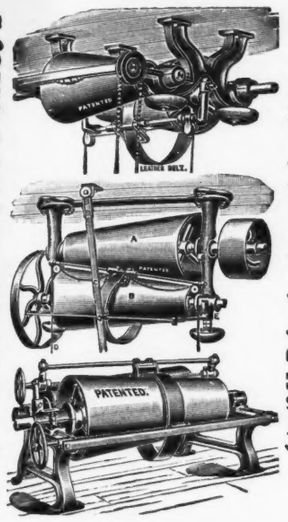
Evans Friction Cone Pulleys



1 to 40 H. P. for changing speed of machinery while running. Send for Catalogue.

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POOLE ENGINEERING & MACHINE CO.
ENGINEERS, FOUNDERS AND MACHINISTS.
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MANUFACTURERS AND DESIGNERS OF ALL KINDS OF
HEAVY MACHINERY,
REQUIRING FIRST CLASS WORKMANSHIP AND MATERIALS.
BAND, ROPE AND FLY WHEELS, FRICTION CLUTCHES, SHAFTING, PULLEYS AND HANGERS.
MACHINE MOLDED AND PLANED GEARING
MACHINERY for WHITE LEAD and FERTILIZER WORKS, GRAIN ELEVATORS and FLOUR MILLS, BRASS, COPPER and TIN PLATE ROLLING MILLS, CABLE and MARINE RAILWAYS.
POOLE-LEFFEL TURBINE WATER-WHEELS
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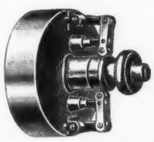
CIRCULARS ON APPLICATION.
IRON CASTINGS 30,000 LBS. TENSILE STRENGTH.



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Self-oiling, Self-centering—Positive and friction combined. Never slips. The most convenient and durable clutch on the market. Circular A for full particulars.

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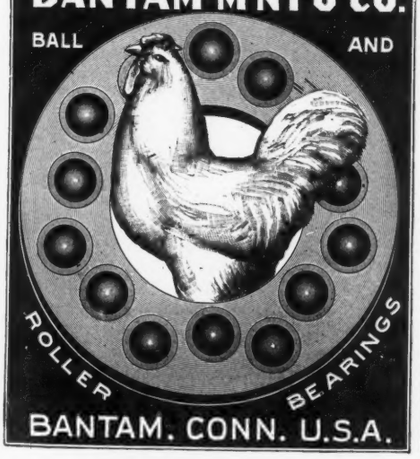
BANTAM M'N'F'G CO.



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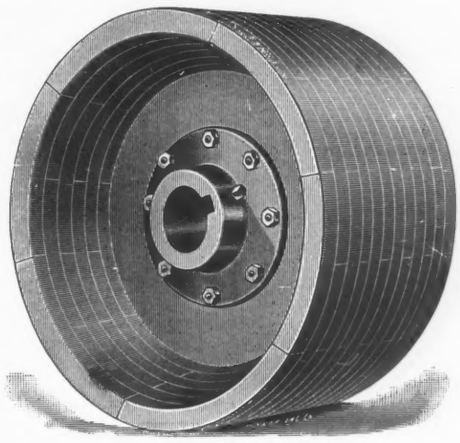
For Dynamos, Trip Hammers or other Heavy Work.

We manufacture a solid web pulley especially adapted for extremely severe service and guarantee that it will do the work specified, no matter how heavy. Style D. built of selected, thoroughly seasoned maple, having an iron center fitted with key seat and set screw, is the lightest, strongest, stiffest and best finished Dynamo Pulley on the market.



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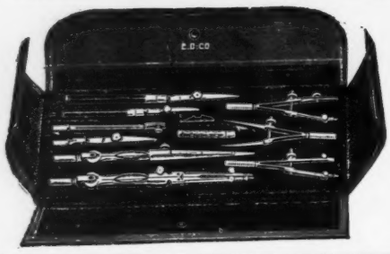

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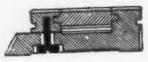

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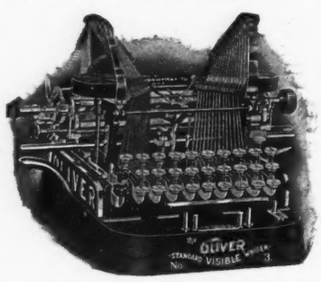

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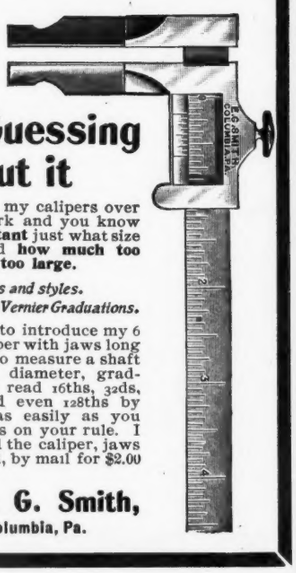

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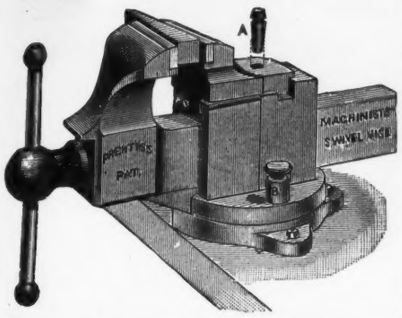

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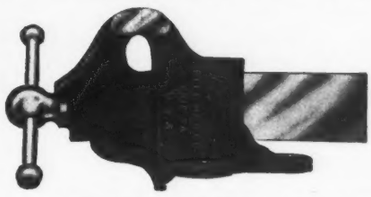

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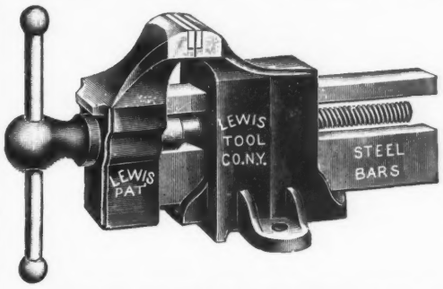

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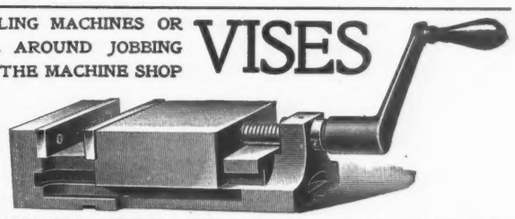

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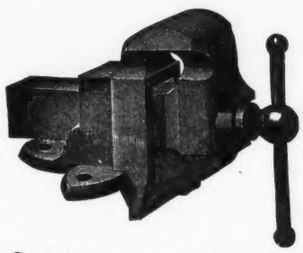

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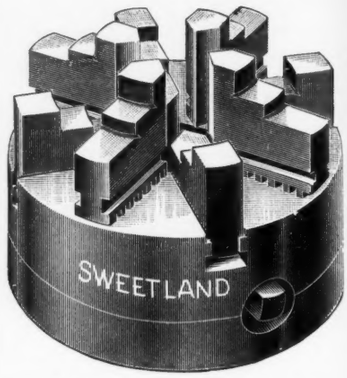

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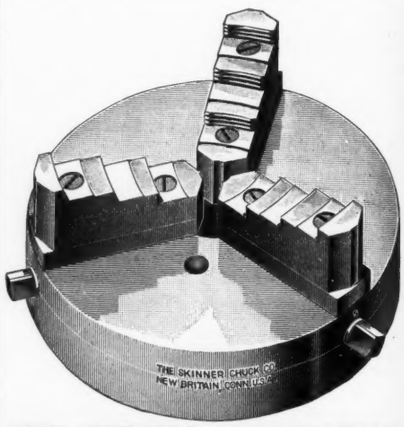

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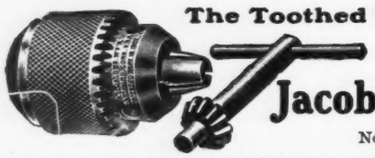

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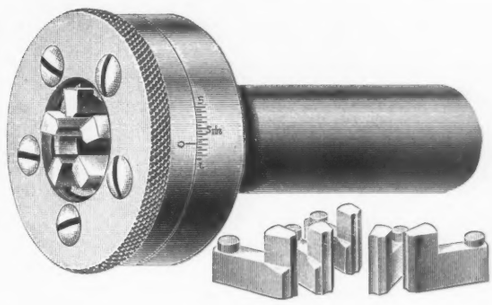

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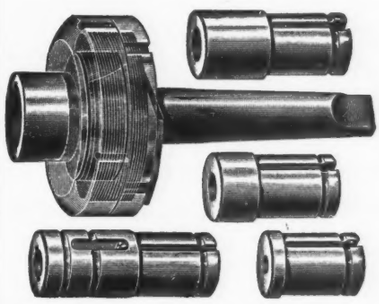

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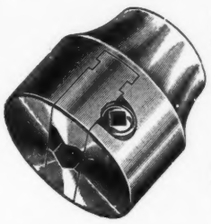

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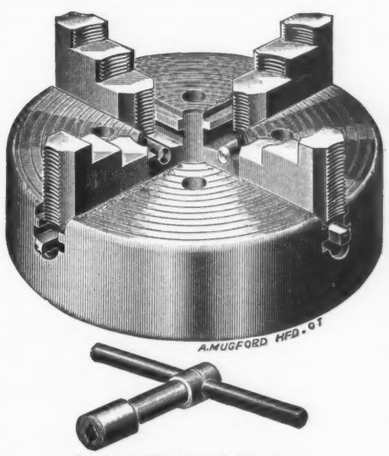

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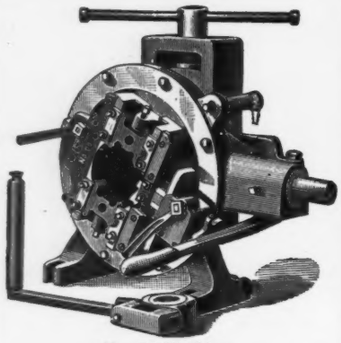

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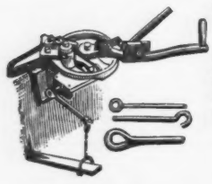

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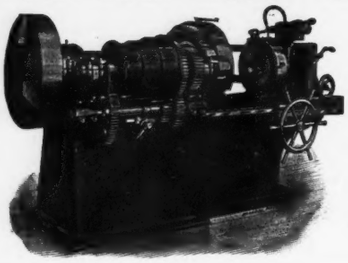

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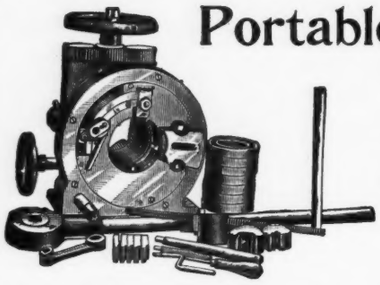

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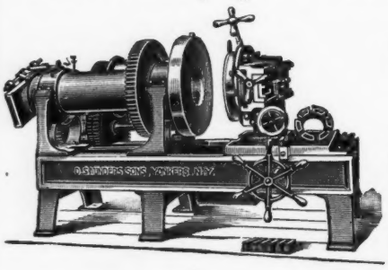

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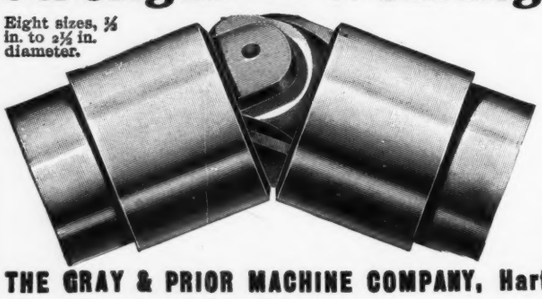

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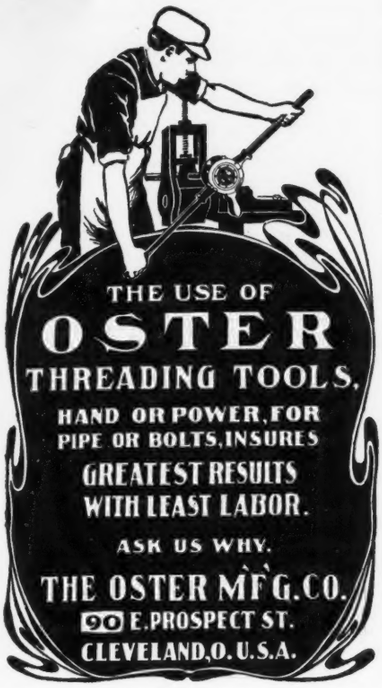
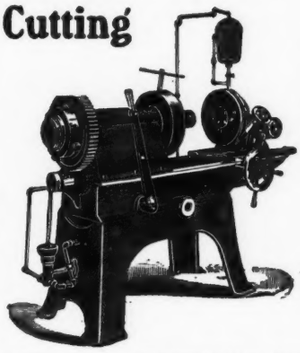
Send for prices and Circular "B."

THE GRAY & PRIOR MACHINE COMPANY, Hartford, Conn., U. S. A.



THE USE OF
OSTER
THREADING TOOLS,
HAND OR POWER, FOR PIPE OR BOLTS, INSURES
GREATEST RESULTS WITH LEAST LABOR.
ASK US WHY.
THE OSTER MFG. CO.
90 E. PROSPECT ST.
CLEVELAND, O. U. S. A.

Rapid and Accurate Pipe Cutting



Capacity of No. 3 Pipe Machine from ⅛ inch to 6 inch pipe.

Fitted with quick opening, adjustable dies; has six changes of speed without removing a gear; is strong, durable and built from new designs.

Send for Catalogue

WILLIAMS TOOL CO., Erie, Pa.

An Absolute Level in Ten Seconds

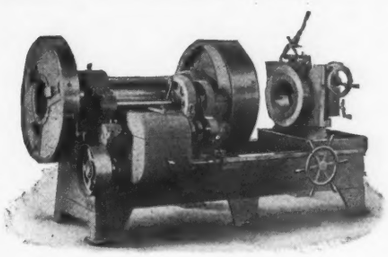
Compare this with the old way—ten to twenty minutes saved, and results certain.

Bowsher's Patent Balancing Way
Is the New Way

Made in 3 sizes and styles, for bench and floor use. Ways chilled and ground, spirit levels attached.

Circular "BW" for details.

The **N. P. BOWSHER CO.**
South Bend, Ind.



DURABILITY.

Which will wear the longest, cast iron cams or hardened steel cams? When the cams in the die head wear, the chasers drop out of gage and a few of the set do all the cutting If all the chasers cut, the thread is better, the strain on them is less and they will last longer. Why not have steel cams when you can get them. We put them in all our machines.

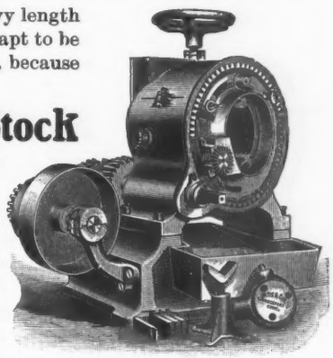
THE STOEVER FOUNDRY & MFG. COMPANY, MYERSTOWN, PA.

It requires a lot of muscle to turn a heavy length of pipe in the dies—it's a slow job, too, not apt to be accurate, and more than all is unnecessary, because you can use a

Forbes Patent Die Stock

and turn the dies round the pipe, saving time, labor and insuring better work.

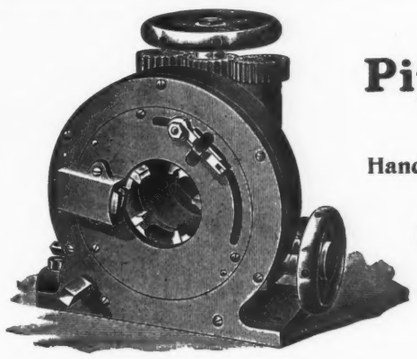
Other important features of this tool are its simple construction, convenience for use in cramped places, the adjustability of dies, which can be replaced if one is lost or broken, and the patent adjustment of shell by which wear is taken up. The Forbes Patent Die Stock is complete in itself—no vise or other accessory needed.



No. 78 Hand or Power Machine. Range 2½ to 4" R. H.

Write for catalogue and prices.

The Curtis & Curtis Co., 8 Garden St., Bridgeport, Conn.



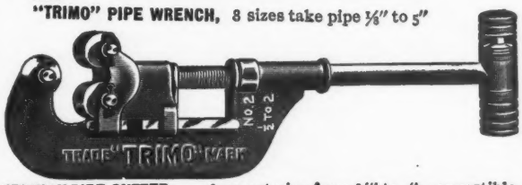
Columbus Pipe Threading Machines.

Hand or Power. Single or Double Vise.

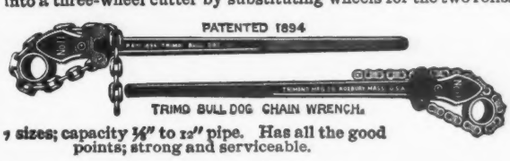
Columbus Gas Engines.

Columbus Machine Co.,
Columbus, Ohio.

"TRIMO" PIPE WRENCH, 8 sizes take pipe ⅛" to 5"



"TRIMO" PIPE CUTTER. 3 sizes cut pipe from ⅛" to 3"; convertible into a three-wheel cutter by substituting wheels for the two rolls.



7 sizes; capacity ¼" to 12" pipe. Has all the good points; strong and serviceable.

"TRIMO" PIPE TOOLS

...THE...

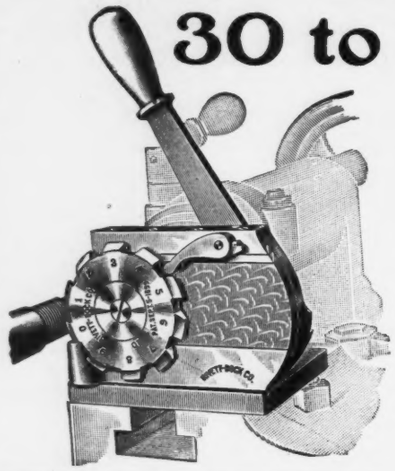
"BIG THREE"

SPECIALTIES OF THE

Trimont Mfg. Co.

ROXBURY, MASS.

30 to 75 Per Cent. Saved



on one class of work amounts to a very tidy little sum at the end of the year. The Rivett-Dock Threading Tool effects this saving over the old way of cutting threads with a single point tool and does better work. The Rivett-Dock Tool is simple in construction, can be operated by any workman, insures absolutely accurate threads, requires infrequent grinding and is practically indispensable for duplicate work.

Let us send you one for thirty days. A trial will convince you.

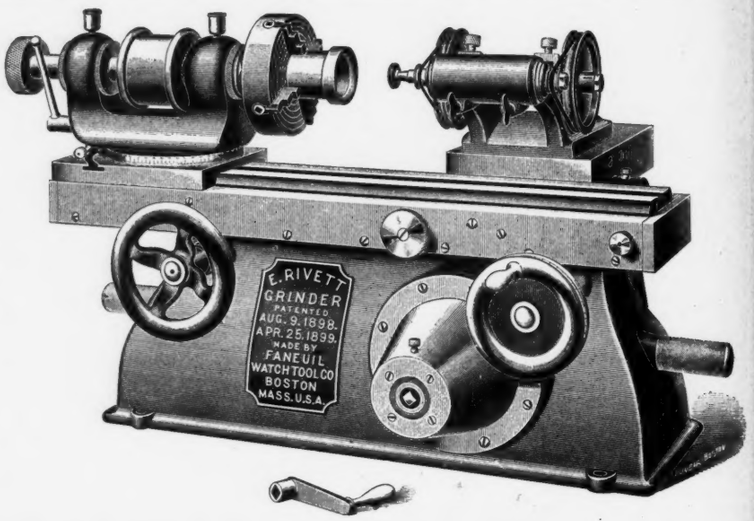
The Rivett-Dock Company, Brighton, Boston, Mass.

Rivett Internal Grinder No. 3

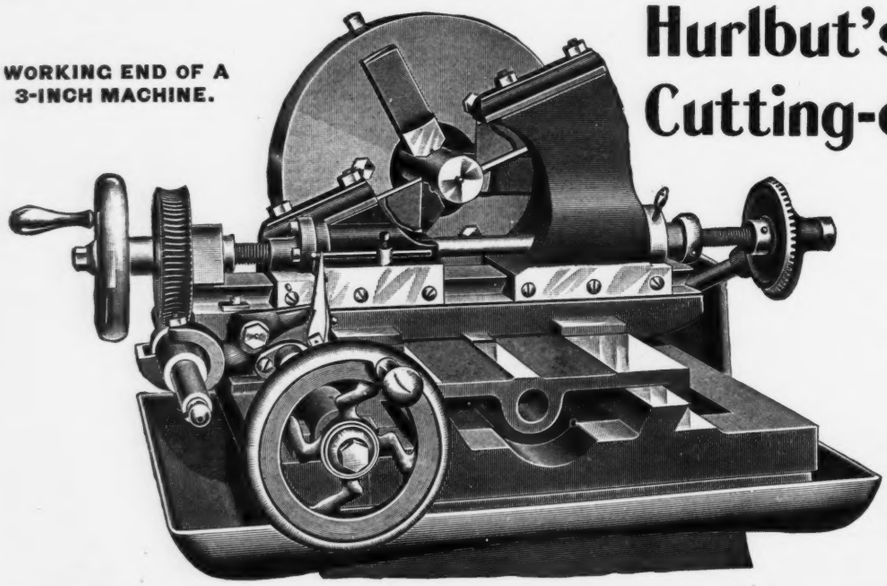
Solves the problem of inside grinding at maximum speed It will attain any speed from 10,000 to 100,000 revolutions per minute and will grind a hole $\frac{10}{1000}$ of an inch as true and as easily as one of large size. Machine has automatic feed so adjusted that the length of stroke will not vary $\frac{1}{1000}$ of an inch; head is adjusted on swivel to allow for grinding at any angle. The ideal machine for grinding gauges, bicycle bearings, rolls for sewing machines or any work that requires rapidity and accuracy.

Catalogue gives full description.

Faneuil Watch Tool Company
Brighton, Boston, Mass.



WORKING END OF A 3-INCH MACHINE.



Hurlbut's Patent Cutting-off Machine

Made in 2-inch, 3-inch, 4-inch 5-inch, 6-inch, 8-inch and 10-inch sizes.

Circulars on application.

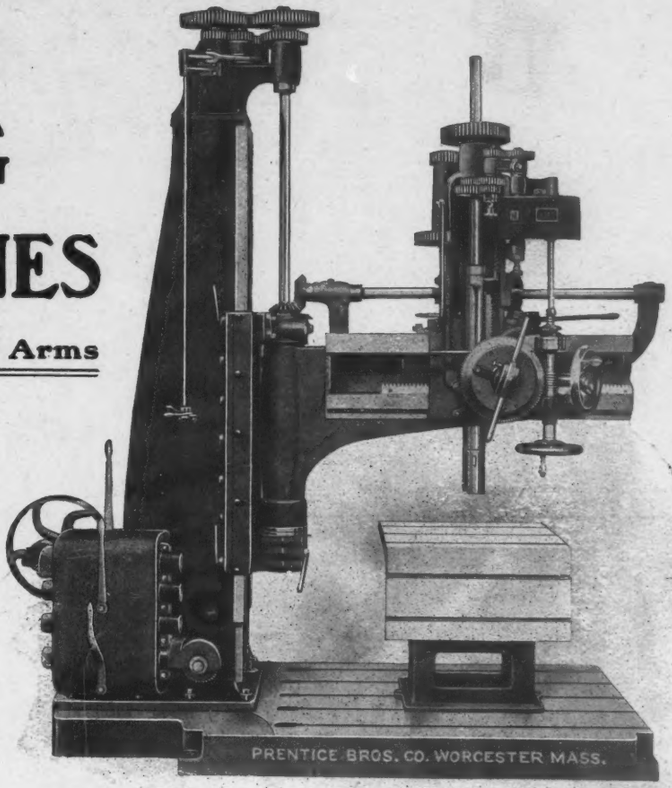
HURLBUT-ROGERS MACHINE CO.
So. Sudbury, Mass.

Besides the best clay and plumbago—brains are the chief thing which enters into the composition of the McCullough-Dalzell crucibles. If interested, write.

McCULLOUGH-DALZELL CRUCIBLE COMPANY, PITTSBURG, PA.

RADIAL DRILLING MACHINES

3, 4, 5, 6, 7, 8 and 9 Foot Arms



VERTICAL DRILLING MACHINES

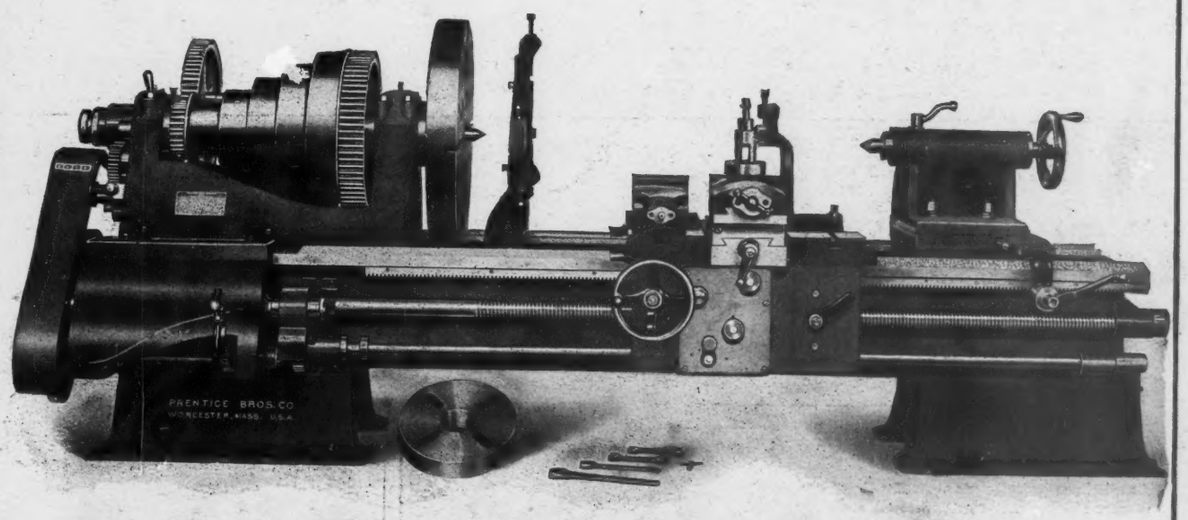
24, 25, 26, 28, 30, 36, 42 and 50 inch Swing.

SMALL DRILLING MACHINES

13, 14, 16, 20, 21 and 23 inch Swing.

ENGINE LATHES

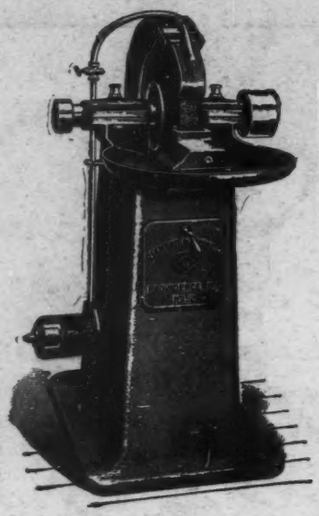
12, 14, 16, 18, 20, 22, 26 and



32 INCH SWING

PRENTICE BROS. COMPANY

WORCESTER, MASS., U. S. A.



Our Water Tool Grinders

are made in five sizes, taking emery wheels 14 x 2; 20 x 2½; 24 x 3½; 30 x 4; 36 x 4 inches.

They are furnished with Countershafts, Settling Tanks, Permanent Truing Devices, and thoroughly satisfactory Pumps.

Catalog and information gladly sent on application.

Diamond Machine Co.
Providence, R. I., U.S.A.

★ STAR HACK SAWS ★

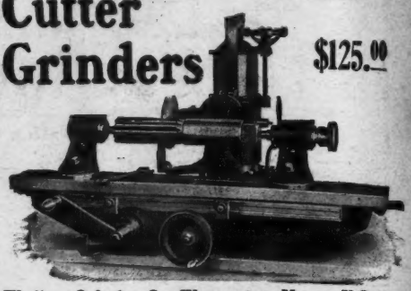
We do not pretend that the Star Hack Saw is as low in price as most other brands in the market, but with cutting qualities considered, we do claim that it is more than 100 per cent. the cheapest. Some dealers and consumers have learned from experience that steel, teeth and holes do not constitute a Hack Saw.

Star Saws are sold by ★ prominent dealers everywhere. Look for the ★ which is stamped on each genuine blade.

Millers Falls Company,
28 Warren Street - NEW YORK, N. Y.

Cutter Grinders

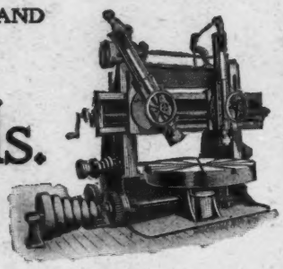
COMPLETE $125.00



Walker Grinder Co., Worcester, Mass., U.S.A.

Boring and Turning Mills.

4, 5, 6, 7 AND 8 FOOT SWING.



Send for photographs and prices.

H. BICKFORD & CO., LaKeport, N. H.

GRINDING and POLISHING MACHINERY

OF ALL KINDS.
"Pull" Countershafts
Catalog on application
Builders Iron Foundry
Providence, R. I.

TRADE MARK

EST. 1863. **BLACK DIAMOND FILE WORKS** INC. 1893.

TWELVE MEDALS awarded at INTERNATIONAL EXPOSITIONS.

GRAND PRIZE GOLD MEDAL at Atlanta, Ga., 1895.

G. & H. BARNETT COMPANY, Philadelphia.

DROP PRESSES

For all Purposes Our Specialty.

MINER & PECK MFG. CO.
PROPRIETORS OF
The Peck Drop Press Works, New Haven, Conn.

Oil Tube Drills

Just the thing for quick work or drilling of deep holes. Made in all sizes.

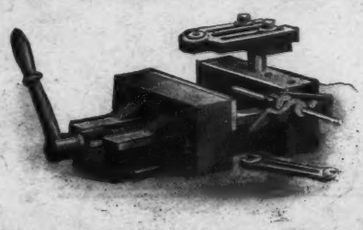
Write for particulars.

CLEVELAND TWIST DRILL COMPANY,
Cleveland. New York. Chicago.

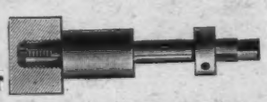
C Trade Mark

Universal Jig Vise

At all times a first class ordinary vise for planer, shaper, miller or drill, and also a jig that covers a wide range of work. Always ready for business.



Broken Tap Remover



Six in set. $\frac{5}{16}$', $\frac{3}{8}$", $\frac{7}{16}$", $\frac{1}{2}$", $\frac{9}{16}$" and $\frac{5}{8}$". Other sizes to order. Sure, strong, simple and the greatest time saver yet. *Sent on trial.*

Yours to try before you buy

The Graham Mfg. Co.
Providence, R. I.

Economic Two Speed Chain Hoist

The J. D. Smith Foundry Supply Co.

Cleveland Facing Mill

Cleveland, Ohio

Everything for the Foundry

300 page Catalogue sent free

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Our Taps

Incorporated 1891.
34 YEARS ON THE MARKET.
HAVE NO SUPERIORS.
Quality and Price Guaranteed.

J. M. CARPENTER TAP AND DIE COMPANY, PAWTUCKET, R. I., U. S. A.